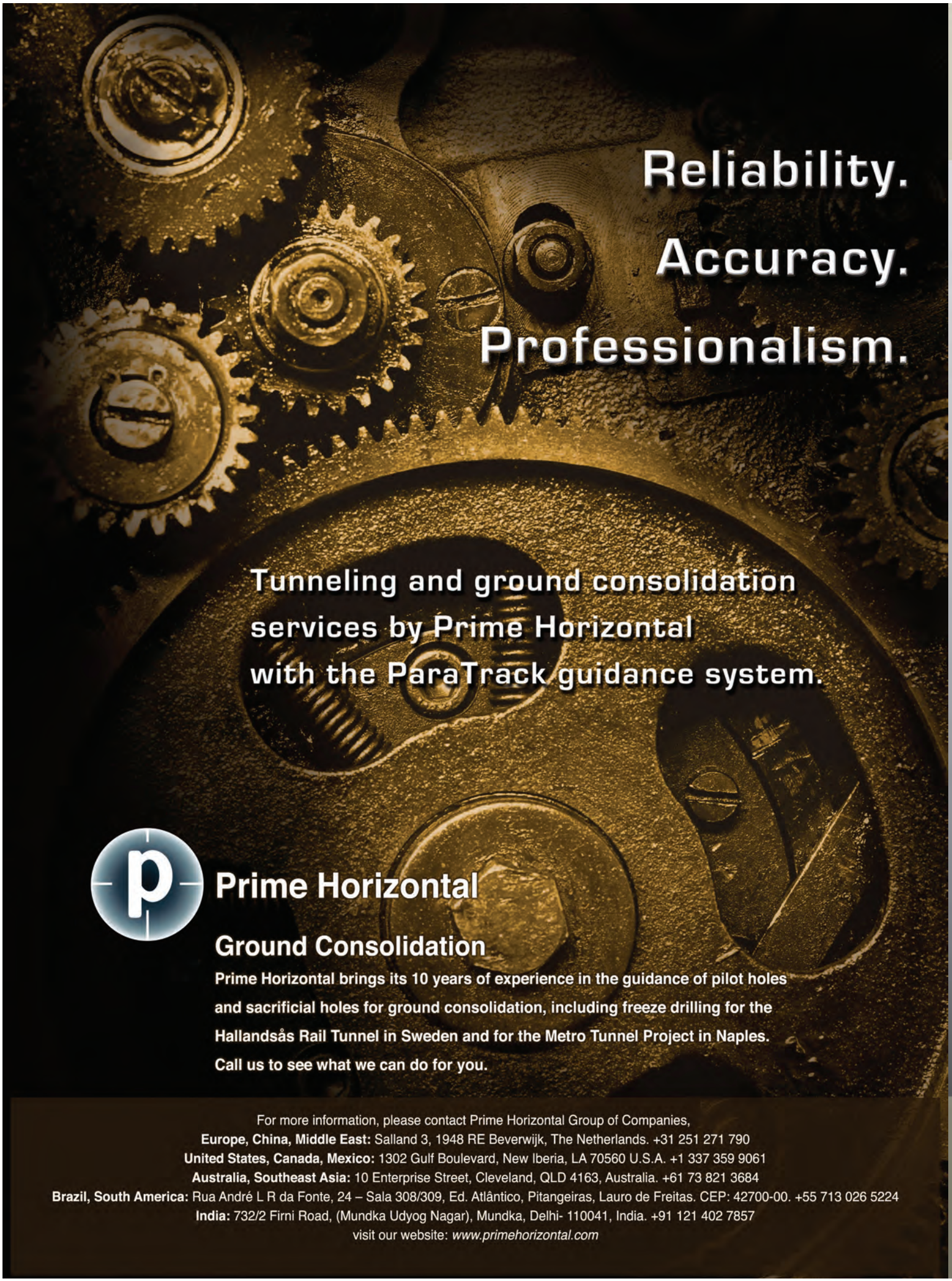
2014 Horizontal Directional Drilling Guide

A COMPREHENSIVE LOOK AT THE NORTH AMERICAN HDD INDUSTRY

2014

A SUPPLEMENT TO Trenchless TECHNOLOGY



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EDITOR'S MESSAGE

It's All about the Oil and Gas

We are back with our fourth — yes, I said fourth — annual *Horizontal Directional Drilling Guide*! When we first published this special supplement in 2011, the HDD market was just starting to find its footing again and we had no idea how strong the response would be from readers and advertisers. The response has been phenomenal!

We love that the HDD market continues to take hold of and expand into new markets. And we love bringing you the stories within the HDD market, showcasing interesting projects, products and trends in one compact and jam-packed book.

Last winter was definitely cruel, with record subzero temperatures and snowfall putting most of North America in an icy vice grip for the better part of the season, resulting in a slower-than-normal start to the first quarter of the 2014 construction season. But expectations remain high for a strong finish for the year.

The HDD market has been on an upward trajectory for the last several years, with a huge catalyst being the oil and gas market. It's all about the pipelines. In 2014, oil and gas continue to be huge drivers of HDD work, with manufacturers working in overdrive to meet the needs of HDD contractors pursuing these projects. The Marcellus and Utica shale plays in New York, Ohio, Pennsylvania and West Virginia, as well as the Bakken shale play in Montana and North Dakota, are providing fertile and profitable ground for HDD contractors. For insightful perspective from manufacturers and contractors, check out assistant editor Mike Kezdi's look at today's HDD market, beginning on pg. 12.

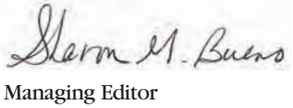
As in past HDD *Guides*, we bring you interesting case studies that highlight different applications of HDD and the different technologies used in those projects. We also have a feature written by associate editor Andrew Farr on the evolution of Digital Control Inc., the industry leader in electronic guidance tracking for the HDD market. Andrew spoke with DCI co-founder John Mercer, who recounts the company's early beginnings and discusses how locating technology has changed over the years. It's a great read that starts on pg. 36.

Our HDD *Guide* wouldn't be complete without two sections: Products Showcase and Drilling Rig Specs. They are both here and bigger than ever. The response to our call for HDD products resulted in an expanded section to present them all to you — awesome! I love our Drilling Rig specs (starting on pg. 14). Each year, we invite the drilling rig manufacturers to submit their rig product fleet for you, giving you a glimpse of what these machines can do. If you need a new rig, this is the place to start!

Finally, a sign that the HDD market is on the rise is the number of HDD educational opportunities. In 2013, we organized an HDD Seminar in Las Vegas — the first the industry has had in some time. In 2015, we are teaming with Arizona State University's Del E. Webb School of Construction to host the 2015 Horizontal Directional Drilling Academy, a two-day intensive course designed to equip attendees with knowledge of HDD pre-construction, design and material selection, construction and operations. The seminar covers everything from drilling fluids to locating to HDD contracts. Through case studies and industry experts, this conference is a must for HDD contractors! Mark your calendars for Feb. 19-20, 2015, in Tempe, Ariz., for this excellent educational opportunity. For more information, visit *www.hddacademy.com*.

The *Trenchless Technology* team enjoys producing the *Horizontal Directional Drilling Guide* and we hope you find it useful, interesting and worth your time in reading it. We can't wait to see how the rest of year unfolds for HDD and look forward to presenting it to you in 2015!

Sharon M. Bueno



Managing Editor

Trenchless TECHNOLOGY

PUBLISHER
Bernard P. Krzys
bkrzys@benjaminmedia.com

EDITORIAL
Editor: James W. Rush
jrush@benjaminmedia.com

Managing Editor: Sharon M. Bueno
sbueno@benjaminmedia.com

Assistant Editor: Andrew Farr
afarr@benjaminmedia.com

Contributing Staff Editors:
Mike Kezdi • Brad Kramer • Keith Gribbins
Kelly Pickerel • Pam Kleineke

SALES + MARKETING
Marketing Director: Kelly Dadich
kdadich@benjaminmedia.com

Brand Sales Manager: Dan Sisko
dsisko@benjaminmedia.com

Regional Sales Representative: Renee Sanders
rsanders@benjaminmedia.com

Conferences Sales Coordinator: Brittany Maurer
bmaurer@benjaminmedia.com

PRODUCTION + FULFILLMENT
Production Manager: Chris Slogar
cslogar@benjaminmedia.com

Lead App Designer/Graphic Designer
Deb McManus

Web/Interactive Manager: Mark Gorman
mgorman@benjaminmedia.com

Audience Development Manager: Alexis R. White
awhite@benjaminmedia.com

Circulation & Fulfillment Coordinator: Lillian Lopeman
llopeman@benjaminmedia.com

REPRINTS
Wright's Media
Ph: 877-652-5295 • Fax: 281-419-5712

BENJAMIN MEDIA

Chief Executive Officer: Bernard P. Krzys
bkrzys@benjaminmedia.com

President: Robert Krzys
robk@benjaminmedia.com

Controller: Marianne Saykes
msaykes@benjaminmedia.com

10050 Brecksville Rd.
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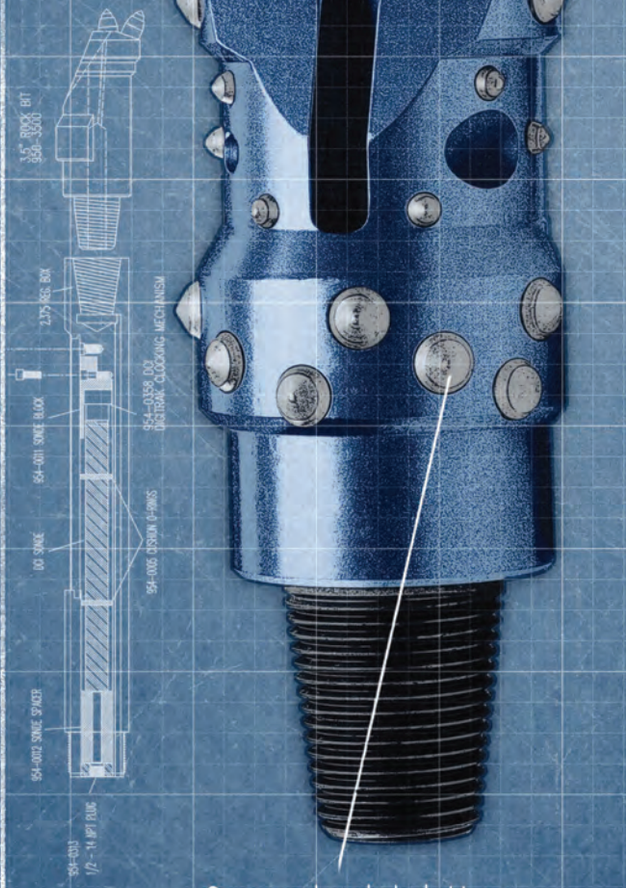

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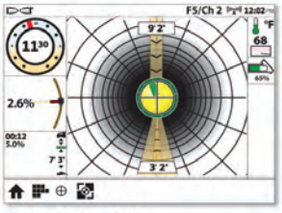
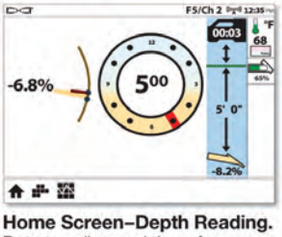


Target Steering.
Large graphical representation of key drill data.



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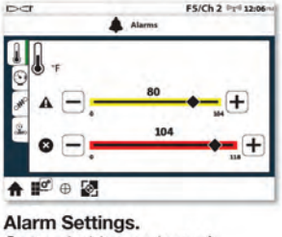

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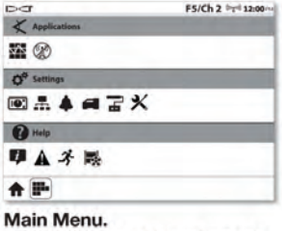

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OIL AND GAS KEEP HDD MARKET BUSY

By Mike Kezdi

Midway through 2014, the horizontal directional drilling (HDD) segment of the trenchless industry continues its steady improvement from the leaner years in 2008-2011.

Those involved in the segment have varying comments about the close of 2013, and how the first half of 2014 is shaping up, but two things remain certain: The oil and gas industry is a huge driver for the HDD market and dealing with the HDD spoils is one of the biggest concerns.

"For Vermeer, and I believe you could say for the industry, as well, the total numbers were down just slightly. The thing to keep in mind is that the year prior, for the industry and Vermeer, was really a big growth year," said Dave Wisniewski, vice president of Vermeer's underground business segment. "To see it wane a little bit was not totally unexpected and certainly no indication of any major directional changes, pardon the pun, in terms of HDD."

Wisniewski attributes this spark in the industry to an awakening in the economy and increased work in the oil and gas industry — particularly the Marcellus and Utica shale plays in New York, Ohio, Pennsylvania and West Virginia and the Bakken shale play in Montana and North Dakota.

One company singing the praises of the oil and gas industry is Southeast Directional Drilling.

"It was our strongest (year) in history," said Todd Barton, president of the Casa Grande, Ariz. company. "Generally, the fourth quarter and beginning of the first quarter are slow periods for the HDD industry. That was not so for 2013, it was strong all the way through and the first quarter of 2014 was a record quarter for us, as well."

Barton attributes this to permitting issues particularly in the shale plays where oil and gas companies are hitting roadblocks especially when it comes to wells that require hydraulic fracturing. These permitting issues are forcing projects that companies typically look to complete in the second and third quarter to the fourth and first quarters. It also equates to drilling contractors remaining busy year-round.

Work in the oil and gas sector brought stability to the horizontal directional drilling market. This has allowed manufacturers to continue research, development and investment in new technologies.

It is no shock that the winter of 2013-2014 was one of the worst on record. For some, Mother Nature played a partial role in a softer end to 2013 and the first quarter of 2014.

The weather contributed to slower than anticipated first quarter sales and HDD contractors were starting spring projects six to eight weeks behind, according to Seth Matthesen, Ditch Witch senior product manager, HDD and drill pipe. Matthesen expects to see a better picture of how 2014 is shaping up by mid-July as contractors' backlog forecast becomes clearer.

GROWTH IN GAS

From new installations to meet the needs of shale gas production to repairing or replacing old lines, gas and oil is an area where HDD contractors have found a home during the down economy.

"It has kept us busy, without it we would be operating at 25 percent capacity or less," said Nick Atkin, chief operating officer of Wisconsin-based Gabe's Construction.

On the other side, Barton says that Southeast did not see a big downturn in its business because the company worked mostly in the oil and gas industry, but what he did see is a change in the projects.

"The discovery of shale plays got hot and heavy in 2008 and you saw a dive from the 42-in. and 36-in. market in the southern states, so in 2008 and 2009 we started getting rigs into these plays," Barton said.

Because most of this work is on the distribution side of things, Barton sees potential growth for larger trunk lines into, or near, the shale plays to help get the products to market.

The growth of this market is one that Wisniewski is happy to extoll.

"Just think about the headlines you read, just think about the general conversation around gas or oil and the shale play. You can't go anywhere in the industry without having discus-

sions about it," he said. "That's just a testament to how important and how prevalent it's become as a source of opportunity for all of us in the underground world."

Matthesen adds that the stability brought on by the oil and gas market allows manufacturers to continue research, development and the investment in new technologies. These investments are always important in manufacturing the best product for the customers' return on investment.

In addition, research, development and innovation are key as manufacturers, contractors and owners alike tackle one of the biggest HDD issues: mud and cuttings disposal.

MINDING THEIR MUD

"Disposal of drilling fluid has always been an issue in HDD," said Ron Halderman, P.E., HDD Division at Mears Group Inc. "Effective cleaning and recycling is, of course, the key. Cost-effective recycling is a challenge that still needs to be met."

Those in the HDD industry often refer to drilling fluid as the lifeblood of projects. Get the mix right and its smooth sailing, get the mix wrong and the project turns into a headache and, worst case scenario, equipment gets lost down hole.

Though drilling fluid is important to HDD projects, its disposal from the project site is one of the biggest challenges contractors face. Mud disposal was a key issue in the *2013 Horizontal Directional Drilling Guide* market overview story and the issue remains today.

"The No. 1 issue we see challenging the HDD industry in 2014 is the ability to dispose of environmentally safe drill fluid/cuttings, which is a combination of bentonite mixed with native ground formation," said Greg Goral, design engineer, Michels Directional Crossings. "Drilling fluid is a necessary consumable imperative to the successful installation of trenchless underground utilities but it can be difficult to dispose of once it has been recycled several times within the operation and has lost its efficient qualities."

Goral, as well as Wisniewski, sees some of the negative perceptions of HDD fluid as overlap with the fluids used during hydraulic fracturing, highlighting a need for better education by the HDD industry as to what its drilling fluid actually is.

"This perception is far from the truth for HDD operations as the bentonite brands used by Michels are NSF-60 approved and not harmful to the environment when properly disposed with regard for the environment," Goral said. "NSF-60 is a standard that signifies a product meets the rigorous standards developed and implemented by a team of scientists and industry experts who set health effects criteria for many water treatment chemicals for which drilling aids are categorized."

On the mud education front, Ditch Witch is working with Oklahoma State University to study what is in the mud, with the ultimate goal of educating and informing utilities and landowners on how to dispose of the by-product.

"In order to make HDD economical for clients, contractors need to be able to land farm non-contaminated drill mud and spoils," Atkin said. This,

Horizontal directional drilling insiders predict a bright future for the market as developing countries require new infrastructure and developed countries require repairs to the infrastructure already in place.

he added, requires proper education of government entities and project owners attempting to permit the spoils disposal via land farming.

Wisniewski applauded the Distribution Contractors Association's (DCA) HDD Committee for working with the industry and regulators including the Environmental Protection Agency and the U.S. Department of the Interior Bureau of Land Management to discuss what HDD fluids are.

"There needs to be a lot more education done in terms of what drilling fluids are, what their purpose is and what, in fact, they are made of," he said. "There is nothing in drilling fluid to be scared of or concerned of in terms of dumping."

Goral concurred, "There must be more education as to what bentonite is and the benefits it provides to not only HDD operations but to lining of fish ponds, use in drilling water wells, base lining for landfills and overall benefits to several industries."

Another component of the mud problem is transportation costs, which Barton said is exacerbated by oil and gas companies looking to get their pipelines installed at the lowest possible cost.

"Sometimes you have to cross three county lines to get to a place to dump and that's time and that's money," he said. "We, as an HDD contractor, constantly have to take on more risks as far as cost is concerned."

Southeast is tackling this transportation issue by assembling a state-by-state database of mud disposal locations and, like many contractors, using a mud recycling system is necessary.

BEYOND MUD

Disposal of spoils may be the biggest concern among HDD contractors but there are other issues on the radar, among them the lack of qualified workers, poor engineering on HDD projects and obstacle avoidance. The latter is becoming more of a concern as underground utility installation becomes the norm.

The lack of qualified workers is not solely an HDD trend but rather and overall trend among many of the skilled trades. As the workforce ages and retires, the amount of people waiting in the wings does not equal those who are leaving both in numbers and in terms of skills.

Mud and cuttings disposal remains one of the biggest challenges horizontal directional drilling contractors face. One of the ways to overcome that challenge is increased education about what is in the mud and cuttings.

"The oil and gas markets have depleted many of the experienced HDD operators," Matthesen states. "The need for quality training programs for customers of all HDD markets has increased due to this occurrence. Training has become something [Ditch Witch has] to keep our eye on and continually develop that in our platforms," he said.

"There needs to be more recruiting done in the trades," Wisniewski said. "There are a lot of great employment and career opportunities in the trades and they are not always made as visible to kids who are in high school."

As far as the projects themselves, Atkin is seeing more poorly designed HDD projects because owners are not hiring qualified engineers and or consultants with past HDD project design experience, as well as a lack of contractor review for constructability.

"Owners need to make sure they are hiring engineering firms that have a history of properly engineered and constructed projects under their belt," Atkin said.

BRIGHT OUTLOOK

Opportunities for HDD operators will continue to abound with a leveling out of new pipe installations and an increased focus on inspection, repair and replacement of old and corroded lines.

Matthesen points to the numerous gas pipeline hits in recent years, such as the line explosion in San Bruno, Calif., which has developed a renewed focus on pipeline integrity and the importance of damage prevention in the HDD industry.

"HDD was not created to fill a need. It was created to fill a desire to provide an alternative methodology. New innovations are sporadic and largely a surprise coming from innovative people. They will happen and the industry needs to be ready to use them," Halderman said. "HDD was created by innovators. It still needs that attitude more than ever."

This focus on inspection, repair and replacement, also holds true in the municipal and utility world. As the economy turns around, the industry insiders see money coming available for much-needed infrastructure improvements.

This potential for growth is not solely in the United States, or North America as a whole, Wisniewski pointed to countries across the globe. From already urbanized locations where infrastructure needs improvement to developing countries where infrastructure has yet to be installed.

"I am still very bullish on the future of trenchless," Wisniewski said. "I think we have opportunities not only because our markets are going to be strong but for general growth overall and I think it's upon us as manufacturers and the industry to educate what the benefits of HDD are."

Mike Kezdi is assistant editor for *Trenchless Technology*.

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With this section, we give you the basic information you need to start a conversation with one of the drill rig manufacturers. This group of manufacturers offers the latest technology for the compact, midsize and maxi rig market. Each rig can be custom-built to meet the needs of your particular project, allowing you to add whatever bells and whistles you desire. New to the lineup this year is McCloskey International, which purchased TR Drills.

Trenchless Technology contacted the industry's rig manufacturers and asked them to provide the specifications for their drill rig product lines. No direct quality comparisons between equipment or manufacturers are implied. All information is provided by the manufacturers. To get additional information, contact the manufacturers directly.

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COMPANY PROFILE

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PRODUCT LINEUP

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PRODUCT HIGHLIGHT

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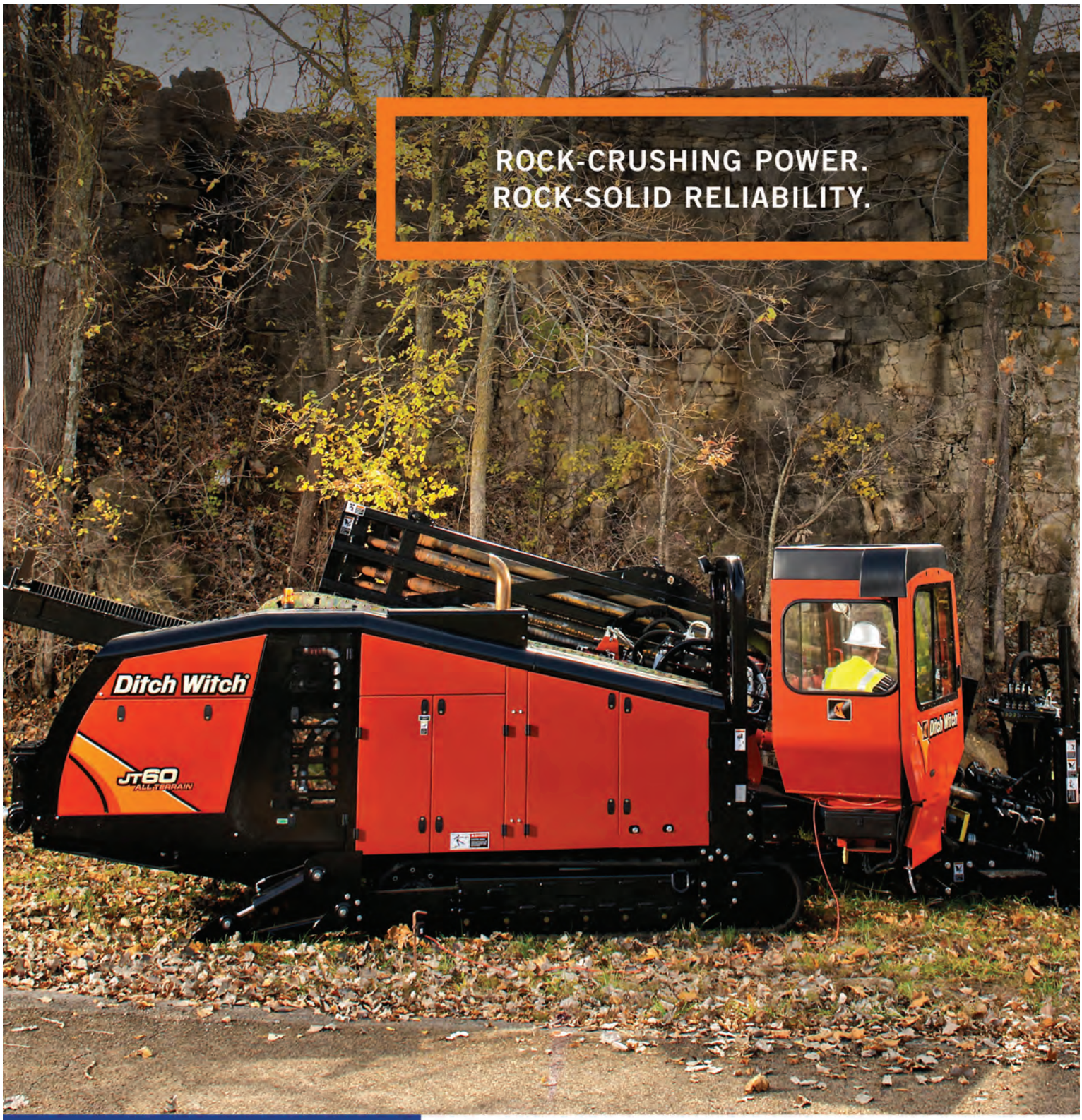
Co/ Model	Thrust/ Pullback (lbs)	Spindle Speed (rpm)	Torque (ft-lb)	Pilot Bore OD	Maximum Backream (in.)	Maximum Bore (ft)	Drill Pipe (ft)	Engine HP	Maximum Fluid Pressure (psi)	Flow Rate (gpm)
DD-110	110,000	150	14,000	6	varies	varies	20	260	1,100	200
DD-110S	110,000	150	14,000	6	varies	varies	15	260	1,100	200
DD-155T	155,000	100	30,000	9	varies	varies	20	275	1,500	450
DD-220T	220,000	95	30,000	9	varies	varies	34	365	1,500	650
DD-440T	440,000	80	60,000	9	varies	varies	34	600	1,500	1,000
DD-625	625,000	90	80,000	13	varies	varies	34	600	1,500	1,000
DD-1100RS	1,100,000	75	100,000	13	varies	varies	34	765	1,500	1,000



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Horizontal Directional Drilling Guide

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COMPANY HISTORY

Barbco has been manufacturing directional drills since the mid-1990s. Since then, we have become known as a manufacturer that "really puts the horsepower behind the specifications." Our directional drills will exceed your expectations of how a drill should perform. The reason is simple. We start with quality components that have stronger duty cycles and couple them to higher flywheel horsepower creating unmatched performance that the operator can actually feel when on a tough pull. Barbco's machines are used throughout the world on a daily basis with a proven track record of long durability in the field for performance, reliability, better quality construction and a simple design for easy maintenance and operation. In times of service needs, Barbco, once again, meets or exceeds our customer's expectations. We have a vast knowledge in field experience both in private, military and government projects and can be of assistance on any project that the equipment is designed to be used for.

PRODUCT LINEUP

Directional Drill Models that are available from Barbco today are:
BD60HP, BD80HP, BD100HP, BD120HP, BD160HP, BD200HP, BD250HP, BD380 and BD500 REMOVE BD500.

PRODUCT HIGHLIGHT

BD200HP (High Performance)

Our BD200HP is one of many size maxi drills that uses a 20-ft drill rod. The BD200HP produces 200,000 lbs of pulling force and a pulling speed of 130 fpm. A generous rotary torque of 35,000 ft-lbs. with a top rotary speed of 110 rpm. Its mud system delivers a true 450 gpm. All of these performances are powered by a 600-hp diesel engine. These powerful performance specifications are no match for the durability we have built into our welded steel frame and rack-and-pinion drilling derrick. Other features include a large on board Drilling Fluid System, Enclosed Cab with Climate Control, Automatic Rod Loader and Automated Steer and Ream Drilling Cycles. We encourage you to compare our specifications and price to any manufacturer in the business.

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BUY/LEASE TIPS

Plan your work and work your plan! Don't run and do your work. Instead, walk and do it safe and right the first time. Use this philosophy when purchasing your next rig and take the time to choose your equipment wisely. Be sure to review the specifications before the price and pay close attention to the components your manufacturer has chosen to use. It could be that your machine was engineered for high parts sales. BEWARE OF THIS AND BUY SMART!

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Co/ Model	Thrust/ Pullback (lbs)	Spindle Speed (rpm)	Torque (ft-lb)	Pilot Bore OD	Maximum Backream (in.)	Maximum Bore (ft)	Drill Pipe (ft)	Engine HP	Maximum Fluid Pressure (psi)	Flow Rate (gpm)	Fluid Tank (gal)
Barbco BD40HP	40,000	250	6,500	--	--	--	--	201	1,000	70	
Barbco BD60HP	60,000	220	12,500	--	--	--	--	225	1,000	130	
Barbco BD80HP	80,000	170	15,000	--	--	--	--	250	1,000	200	
Barbco BD100	100,000	170	15,000	--	--	--	--	250	1,000	275	
Barbco BD120	120,000	125	20,000	--	--	--	--	440	1,000	275	
Barbco BD160HP	160,000	135	25,000	--	--	--	--	540	1,200	325	
Barbco BD200	200,000	110	35,000	--	--	--	--	*600	1,200	*450	
Barbco BD250	250,000	120	45,000	--	--	--	--	*630	1,200	*450	
Barbco BD380	380,000	100	60,000	--	--	--	--	700	--	--	

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Web: *www.ditchwitch.com*

COMPANY HISTORY

Specializing in the design, manufacture and distribution of premium underground construction equipment, the Ditch Witch organization is a one-stop source for trenchers, vibratory plows, backhoes, electronic guidance and utility locating tools, horizontal directional drilling systems, drill pipe, downhole tools, chain, teeth and sprockets, vacuum excavation systems and mini skid steers. All of these products are recognized around the world for their advanced design, rugged construction, long-term durability, ease of use, and reliability. This product line represents the most complete range of equipment for installing utilities underground. The Ditch Witch name is one you can trust for your equipment and financial needs. Ditch Witch Financial Services (DWFS) is a full-service provider, offering a wide variety of finance and lease options to meet your individual requirements. Construction professionals can find more details about products, event updates, special financing offers, videos and other informative special features on the Ditch Witch organization's Facebook and Twitter (@ditchwitch) pages, Flickr photos, and the company's YouTube (*www.youtube.com/user/CMWorks)* channel. For more information, please visit *www.ditchwitch.com*, send us an email at i*nfo@ditchwitch.com*, or call our toll-free at (800) -654-6481.

PRODUCT LINEUP

Through customer feedback from years of experience we provide horizontal directional drilling units for all types of job conditions. The Ditch Witch horizontal directional drilling product line consists of eleven rigs. Our product line up starts with a JT5 at 5,000 lb pullback force up to 100,000 lbs pullback force. We also have three All Terrain units ranging from JT30 AT up to JT100 AT. Our product designations are: JT5, JT922, JT1220, JT20, JT25, JT30, JT30 All Terrain, JT60, JT60 All Terrain, JT100, JT100 All Terrain. To complement our directional drills, we provide our customers with a comprehensive line of HDD tooling, drill pipe, and electronic guidance tools.

PRODUCT HIGHLIGHT

Ditch Witch JT60 All Terrain Horizontal Directional Drill

The JT60 All Terrain is equipped with 60,000 lbs of thrust and pullback plus 9,000 ft-lbs of rotational torque — a powerful combination that results in exceptionally efficient and productive installation of utilities. Powering each drill is the contractor's choice of a 190-gross-hp Tier 3 or 200-gross-hp Tier 4i diesel engine. Both engines provide sufficient power for each drill's mechanical and hydraulic components, including an onboard, 150-gpm fluid pump that helps ensure productive drilling at greater distances. The pump is enclosed to reduce noise and protect components from harsh conditions.

Co/ Model	Thrust/ Pullback (lbs)	Spindle Speed (rpm)	Torque (ft-lb)	Pilot Bore OD	Maximum Backream (in.)	Maximum Bore (ft)	Drill Pipe (ft)	Engine HP	Maximum Fluid Pressure (psi)	Flow Rate (gpm)	Fluid Tank (gal)
Ditch Witch JT5	4,100/5,000	195	550	2.5	4.5		4'11"	24.8	750	5	N/A
Ditch Witch JT922	9,000/9,000	186	1,100	3	variable		6	53.5	750	13	40
Ditch Witch JT1220	10,000/12,000	180	1,400	3.5	variable		10	60	1,250	15	N/A
Ditch Witch JT20	17,000/20,000	225	2,200	4	variable		10	74	1,500	32	n/A
Ditch Witch JT25	27,000/27,000	220	4,000	4.5	variable		9'8"	130	1,200	50	N/A
Ditch Witch JT30	24,800/30,000	225	4,000	4.5	variable		9'8"	148	1,500	50	N/A
Ditch Witch JT30 All Terrain	24,800/30,000	225	4,000	4.75	variable		9'3"	148	1,500	50	N/A
Ditch Witch JT60	60,000/60,000	240	9,000	5	variable		15	200	1,300	150	N/A
Ditch Witch JT60 All Terrain	60,000/60,000	240	9,000	6.25	variable		15	200	1,300	150	N/A
Ditch Witch JT100	70,000/100,000	210	12,000	6	variable		14'9"	268	1,000	230	N/A
Ditch Witch JT100 All Terrain	70,000/100,000	210	12,000	6.25	variable		14'1.5"	268	1,000	120	N/A

HERRENKNECHT

162 132nd Ave. E, Ste. 200
Sumner, WA 98390
Ph: (253) 447-2302
Web: *www.herrenknecht.com*

COMPANY HISTORY

In 1977, Martin Herrenknecht founded the Herrenknecht GmbH, which became a joint stock company (AG) in 1998. Today, Herrenknecht delivers cutting-edge tunnel boring machines for all ground conditions and in all diameters — ranging from 0.10 to 19 m — and technical solutions to sink vertical shafts, as well as to excavate sloping shafts. In 2012, the Herrenknecht Group achieved a total operating performance of 1,135 million Euro. It employs around 5,000 members of staff worldwide including more than 200 trainees. In the area of modern trenchless technology, Herrenknecht can look back on almost 30 years of experience on projects worldwide. In addition to HDD, Herrenknecht is continuously developing new technologies for the pipeline industry, e.g. Pipe Thruster, Direct Pipe and Pipe Express.

PRODUCT LINEUP HDD

The maxi and mega rigs developed and manufactured by Herrenknecht exert pulling forces of between 120,000 and 1,349,000 lbs (600 and 6,000kN) and achieve a maximum torque of between 35,000 and 110,000 ft-lbs, depending on the model. All Herrenknecht HDD rigs have their own diesel-powered energy supply, housed in sound-proofed 20ft containers. The capacity of these power packs, as we call them, can vary from 300 to more than 1,300 hp, depending on the application. These rigs are remarkable not only for their performance capacity but also for their construction design. We offer frame, trailer, crawler and modular rigs. We are also specialized in manufacturing tailor made HDD Rigs according to customers specification.

PRODUCT HIGHLIGHT

Herrenknecht HK250C – new crawler rig generation. With 250 metric ton or 550,000 lbs of push/pull force, the German engineered and built Herrenknecht HDD workhorse has now been put on track for optimum jobsite mobility. The most popular Herrenknecht maxi rig size is now available also as a crawler version with a reasonable Unit weight of only 92.000lbs ready to drill. The onboard sound proof power pack is driven by a 640-hp, CAT C18 engine ready to deliver fully adjustable 67,000 ft-lbs of torque. Thereby the power pack noise rating is at only 80dB(A) at a distance of 7 m. The main feature of the drilling system consists of the strong and full-way moveable Breakout unit, which variably clamps up to 12-in. diameter tool joints, furthermore the carriage with its unique force and torque measurement is greater than other market offers. Customers can choose between the 10 or 20 ft Control Cabin with the worldwide field proven Herrenknecht control set up consisting of Touchscreen Visualization, Operator chair with easy to operate joysticks for full control and full information. The system also includes data logging, computer diagnostics and the possibility for online remote area access for information exchange or service from anywhere in the world.

MAINTENANCE TIP

Through our worldwide service network Herrenknecht provides service wherever you are drilling.

BUY/LEASE TIP

Within the Herrenknecht rental fleet, HDD-Rigs and other HDD equipment, like Pipe Thruster, High-Pressure Mud Pumps, Mobile Breakout Units etc., can be rented. This enables the client also to test the equipment seriously before buying. Part of the paid rental rates will be considered in the purchase price if the equipment is taken over after a rental contract.

Co/ Model	Thrust/ Pullback (lbs)	Spindle Speed (rpm)	Torque (ft-lb)	Pilot Bore OD	Maximum Backream (in.)	Maximum Bore (ft)	Drill Pipe (ft)	Engine HP	Maximum Fluid Pressure (psi)	Flow Rate (gpm)	Fluid Tank (gal)
HK100C	220,000	80	44,250	8 1/2	48	4,000	31.5	443	1,500	600	N/A
HK150C	330,000	72	51,650	9 7/8	48	6,000	31.5	590	1,500	760	N/A
HK150T	330,000	72	51,650	9 7/8	48	6,000	31.5	590	1,500	760	N/A
HK250C	551,000	72	66,400	12 1/4	72	8,000	31.5	644	1,500	1,000	N/A
HK250T	551,000	72	66,400	12 1/4	72	8,000	31.5	644	1,500	1,000	N/A
HK300T	661,000	72	66,400	12 1/4	72	9,000	31.5	644	1,500	1,000	N/A
HK400C	881,000	60	88,500	15	80	12,000	31.5	1,288	1,500	1,200	N/A
HK400T	881,000	60	88,500	15	80	12,000	31.5	1,288	1,500	1,200	N/A
HK400M	881,000	60	88,500	15	80	12,000	31.5	1,288	1,500	1,200	N/A
HK500T	1,102,000	60	103,300	17 1/2	80	15,000	31.5	1,288	1,500	1,200	N/A
HK600T	1,349,000	60	109,200	20	80	15,000	31.5	1,288	1,500	1,200	N/A

MCLAUGHLIN

2006 Perimeter Rd. | Greenville, S.C. 29605 | **Ph:** (864) 277-5870 | **Web:** *www.mightymole.com*

COMPANY HISTORY

For more than 85 years, McLaughlin has been actively involved in the drilling tool industry. During that time, McLaughlin has developed a reputation for designing and building dependable, low maintenance trenchless construction equipment. McLaughlin takes pride in providing solutions for OEMs and the underground industry.

PRODUCT LINEUP

MCL 10H pit-launched directional drill

PRODUCT HIGHLIGHT

The MCL 10H is a pit-launched directional drill that fits into a tight footprint with either a 5-ft and 7-ft model. This drill has 1,030 ft-lbs of torque and 13,250 lbs of pullback. The MCL 10H is ideal for installing up to 12-in. water and gas lines on projects with setback restrictions.

MAINTENANCE TIP

Basic equipment preventative maintenance and inspection of hoses, fittings and fluid levels increase jobsite productivity by reducing downtime. Wear components should be inspected prior to project mobilization.

BUY/LEASE TIP

The McLaughlin MCL10 is a compact, high performance Pit Launch Directional Drill for installations up to 10 in. diameter. The Mcl 10 Pit Launch machine is ideal for water service installations and crossings where easement restrictions do not allow for surface launch HDD methods.

Co/ Model	Thrust/ Pullback (lbs)	Spindle Speed (rpm)	Torque (ft-lb)	Pilot Bore OD	Maximum Backream (in.)	Maximum Bore (ft)	Drill Pipe (ft)	Engine HP	Maximum Fluid Pressure (psi)	Flow Rate (gpm)	Fluid Tank (gal)
MCL 10H											
(5-ft version)	17,670/13,250	0 to 125	1,030	3	12	180	2.33	Hydraulic	1,000	6	230
MCL 10H (											
7-ft version)	17,670/13,250	0 to 125	1,030	3	12	180	4	Hydraulic	1,000	6	230

MCCLOSKEY INTERNATIONAL

1 McCloskey Road
Keene, Ontario, CANADA K9J 0G6
Ph: (877) 876-6635
Web: www.mcloskeyinternational.com

COMPANY HISTORY

Since 1985, McCloskey International has been bringing durable, high production equipment to customers worldwide. The McCloskey D Series Horizontal Drill Rigs set new standards in HDD with the most torque and horsepower with the smallest footprint in their class. Combining brains and brawn, these rugged and reliable drills are ready to tackle the toughest jobs.

COMPANY LINEUP

DIS and D40

COMPANY HIGHLIGHT

The McCloskey Dl5 Horizontal Drill Rig setsa new standard in HDD with the most torque and horsepower in the smallest footprint in its class. An advanced electric hydraulic system delivers more horsepower to the ground, better fuel efficiency and guarantees 14,850 lbs of thrust/pullback while simultaneously delivering 1,600 ft lbs of rotation. The McCloskey D15 boasts a fully featured microcomputer supporting internet and satellite communications, while interactive diagnostics alert operators to service and supply needs, or to order parts and regularly scheduled maintenance. Combining brains and brawn, the rugged and reliable McCloskey Dl5 drill is ready to tackle the toughest jobs

MAINTENANCE TIP

Interactive diagnostics onboard both models of the McCloskey D series alert operators to service and supply needs and regularly scheduled maintenance. In addition, grease points are located in a central, accessible location for ease of maintenance, ensuring more uptime and greater productivity.

Co/ Model	Thrust/ Pullback (lbs)	Spindle Speed (rpm)	Torque (ft-lb)	Pilot Bore OD	Maximum Backream (in.)	Maximum Bore (ft)	Drill Pipe (ft)	Engine HP	Maximum Fluid Pressure (psi)	Flow Rate (gpm)	Fluid Tank (gal)
McCloskey D15	14,850	150	1600	2.5	N/A	N/A	6	59	600	25	7
McCloskey D40	38,500	160	5200	2.5	N/A	N/A	10	218	1500	100	10

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– Scott Sanchez,
S&S Drilling, Corona, California

For more information call Melfred Borzall at 800-558-7500 (outside the U.S. call 805-739-0118) or visit www.melfredborzall.com

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TT Technologies Inc.
(North American Partner)
Ph: (800) 533-2078
Web: *www.prime-drilling.de*

COMPANY HISTORY

Prime Drilling is a global leader in the design, development and production of advanced horizontal directional drilling rigs and allied equipment. We understand that a successful crossing is particularly dependent on the reliability of the equipment involved. For this reason, it is not enough for us to focus on superior technical characteristics. We are driven to delivery robust, low-maintenance drill rigs that bring top performance in the most demanding environments. Today, there are more than 150 Prime Drilling HDD rigs in successful operation around the world. Our products and services are backed by a highly qualified team with decades of experience in the field of horizontal directional drilling technologies.

PRODUCT LINEUP

HDD rigs with pull force from 25 up to 600 tons, pipe pusher, bentonite pumps, mixing units, recycling units, drill rods, reaming tools, measurement equipment and all necessary accessories.

PRODUCT HIGHLIGHT

Current highlight is a drilling rig for execution of horizontal and vertical drills. The drilling angle for HDD is 6 to 16 degrees and for vertical drills 16 to 90 degrees. This drilling rig is available with 100-, 250- and 500-ton pull forces, torque ranges between 36,878 and 110,634 ft-lbs and the drive power between 449 and 1,320 HP. Particularly noteworthy is the rod handling system with loading crane and manipulator. The magazine contains ø 3.1/2, 5 and 7 in., as well as Range 2- and 20-ft rods. The drilling rig is available with self-propelled crawler or with steel frame and has rack-and-pinion drive, so that pull and push force are equal.

Co/ Model	Thrust/ Pullback (lbs)	Spindle Speed (rpm)	Torque (ft-lb)	Pilot Bore OD	Maximum Backream (in.)	Maximum Bore (ft)	Drill Pipe (ft)	Engine HP	Maximum Fluid Pressure (psi)	Flow Rate (gpm)	Fluid Tank (gal)
PD 40	88,200	185	16,250		32	2,600	16	300	435	272	NA
PD 50	110,250	185	22,500		36	2,900	16	300	435	272	NA
PD 60	135,000	185	22,500		40	3,200	16	300	435	272	NA
PD 80	180,000	185	33,300		40	3,200	16	300	435	272	NA
PD 150	337,000	41	52,000		47	6,500	32	450	NA	NA	NA
PD 200	450,000	41	52,000		55	7,800	32	640	NA	NA	NA
PD 250	562,000	24	66,000		55	8,500	32	640	NA	NA	NA
PD 500	1,125,000	30	133,000		86	8,500	32	1,196	NA	NA	NA

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Horizontal Directional Drilling Guide

TORO

8111 Lyndale Ave.
Bloomington, MN 55401
Ph: (952) 887-8861
Web: *www.toro.com*

COMPANY HISTORY

Since 1914, The Toro Co. has built its reputation on providing quality products and service to professionals who create, maintain, and preserve outdoor environments. Today, professionals and contractors around the world count on Toro products to stand up to the demands of heavy use, season after season. As a leading manufacturer of turf maintenance equipment, precision irrigation solutions, and equipment for trenching, plowing, excavating and horizontal directional drilling, Toro products are aimed at allowing you to do your job more efficiently and profitably.

PRODUCT LINEUP

Horizontal Directional Drills: DD2024 & DD4045

PRODUCT HIGHLIGHT

When productivity counts, the new Toro DD4045 horizontal directional drill delivers. Combining 40,000 lbs of best-in-class thrust and pullback, along with 4,500 ft-lbs of torque and drilling fluid pump infinitely variable up to 70 gpm, the DD4045 provides the flexibility to perform a variety of different bores. Operators will appreciate the flexibility to use either single or dual joystick controls while drilling, the large multi-function LCD display and the clear visibility of the tool joint that comes from having open-top vice wrenches. Optional enclosed operator cabin.

MAINTENANCE TIP

To ensure a successful bore, keep your drill pipe in top condition:

1. Use proper lubrication. Use a zinc- or copper-based tool compound; do not use petroleum-based grease!

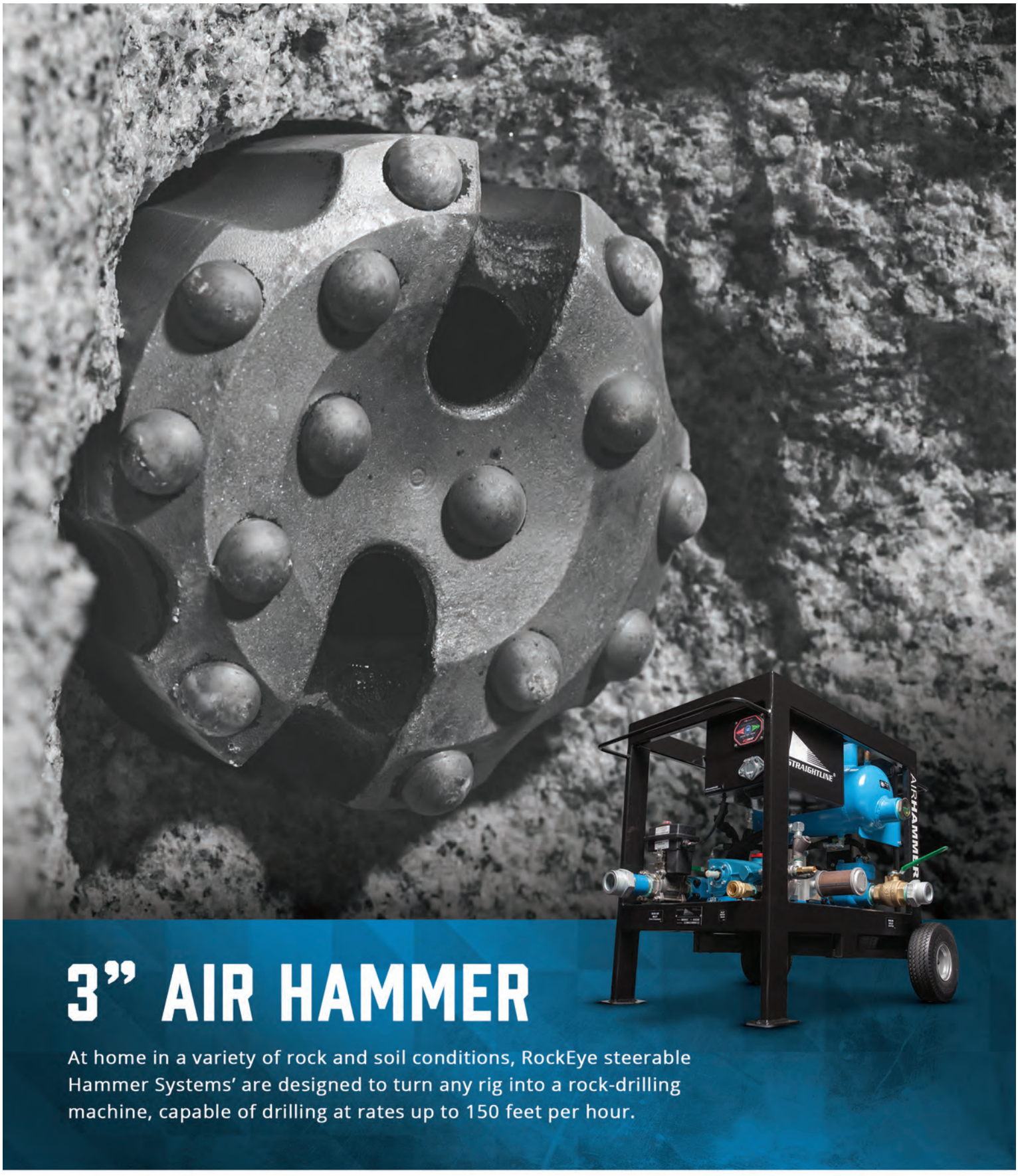
2. Don't exceed the recommended torque specification for your pipe.

3. Clean threads and inspect pipe after each bore. Use a caliper to measure the diameter of the tool joint; replace pipe when diameter is reduced by 20 percent.

BUY/LEASE TIP

Start with your machine utilization goals. Determine how many hours you plan to put on the machine, and over what period. Use comparable used equipment values to estimate your potential re-sale value. Once you've mapped that out, factor in all the other variables, including: warranty, extended protection plans, depreciation, tax advantages for purchase of new equipment, and down payment amount, to name a few.

Co/ Model	Thrust/ Pullback (lbs)	Spindle Speed (rpm)	Torque (ft-lb)	Pilot Bore OD	Maximum Backream (in.)	Maximum Bore (ft)	Drill Pipe (ft)	Engine HP	Maximum Fluid Pressure (psi)	Flow Rate (gpm)	Fluid Tank (gal)
DD2024	20,000	0-200	2,400	4	N/A	N/A	10	74	1500	0-30	500 or 1,000
DD4045	40,000	0-225	4,500	4	N/A	N/A	10	160	1500	0-70	500 or 1,000



3" AIR HAMMER

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30 YEARS 1984-2014

HORIZONTAL DIRECTIONAL DRILLING DONE RIGHT

StraightLine specializes in the design, development and manufacture of equipment for the Horizontal Directional Drilling industry. Regardless of the brand of drill, size of drill or the ground conditions, we are committed to make your HDD operation the very best it can be.

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TT TECHNOLOGIES

2020 E. New York St. | Aurora, Ill. 60502
Ph: (630) 851-8200 | **Web:** *www.tttechnologies.com*

COMPANY HISTORY

TT Technologies Inc., Aurora, Ill., is a manufacturer of trenchless technology equipment for the installation and replacement of water, sewer, gas and electric utilities. The equipment is field proven, logging more than 45 years of experience. With more than 200 patents worldwide, TT Technologies is a leader in trenchless applications ranging from pipe pulling, pipe ramming, pipe bursting, sliplining, and directional boring. A nationwide network of regional customer service offices and distribution locations assures products and expertise are always nearby. Comprehensive hands-on training seminars are held at the corporate offices in Aurora, Ill., as well as regional shows, seminars, and demonstrations throughout North America each year.

PRODUCT LINEUP

TT Technologies full line of trenchless equipment includes: Grundomat piercing tools, Grundodrill directional drills, Grundosteer guided piercing tools, Grundocrack pipe bursting tools, Grundoram pipe ramming tools, Grundomudd bentonite mixing and delivery systems, Grundowinch constant tension winches and Grundopit mini-directional drill rigs.

PRODUCT HIGHLIGHT

The compact Grundodrill 4X is designed for residential service, small diameter main installations and "last mile" operations, offering 9,800 lbs of thrust and pullback. Using the compact drill is less intrusive and ideal for areas where larger units are not an option. The drill features a dual hydrostatic pump system and a four-auger stake down system that provides greater stability. The Grundodrill 4X also comes with the exclusive Smart Vice system that performs vice cycling operations automatically.

Co/ Model	Thrust/ Pullback (lbs)	Spindle Speed (rpm)	Torque (ft-lb)	Pilot Bore OD	Maximum Backream (in.)	Maximum Bore (ft)	Drill Pipe (ft)	Engine HP	Maximum Fluid Pressure (psi)	Flow Rate (gpm)	Fluid Tank (gal)
40/60	13,200/8,800	110	662	2.1	4	200	2	23	800	10	225
4X	9,800	230	950	2.5	10	320	5	37.5	800	10	225
15XP	33,047	180	3,262	4	20	985	32.75	142	870	40	2,000
18ACS	40,465/44,961	200	7,375	6.5	24	1,000	32.75	198	870	40	2,000

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COMPANY HISTORY

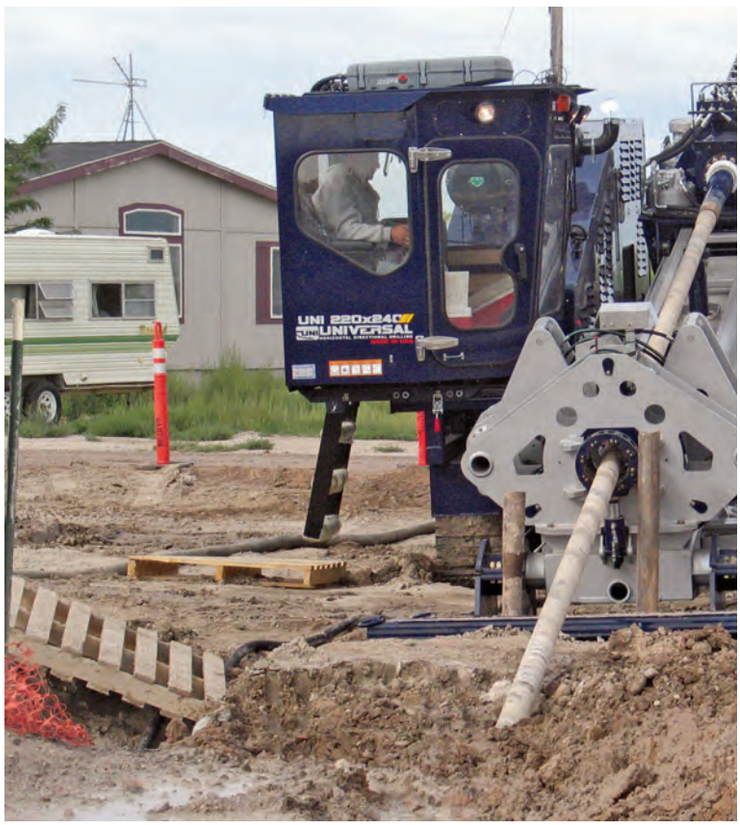
With leading position in engineering and production of custom horizontal directional drills and equipment, we are continuing our growth strategy with the new models and product lines at the new state-of-the-art facility.The great demand from the global market of our equipment, our old Ohio facility has reached the limit of its capacity with regards to the production capacities and technological innovation. It was therefore clear that it would not be possible to continue expanding our product line in Ohio. A new production site that would meet the requirements of the brand name Universal HDD had to be found — Lake Zurich, Ill. For Universal HDD the philosophy of creating highest quality equipment and services is not enough. We must continue to push the limits of the industry. In our new home we prove that we have done so since the opening in 2006. The new assembly plant incorporates the latest advances in construction equipment manufacturing as it aims to meet customer needs and expectations. Modern, modular manufacturing allows flexible, demand-orientated equipment production. In close collaboration with well-established service providers, the production process can be dynamically adapted at any time to meet current requirements. Moreover, modular production improves quality as well as reducing costs.

PRODUCT LINEUP

Universal HDD remains to be the leader in design and manufacture of custom horizontal directional drills and equipment. In 2014, we introduced new and upgraded line of rigs: UNI 36x50, UNI 70x90, UNI 110x120, and UNI 250x400. These drills feature the most advanced technology in the industry, while maintaining the simple design, high productivity and reliability. Today, more than ever, we are committed to utilizing every resource, to provide the highest quality products and to push industry's standards.

PRODUCT HIGHLIGHT

Our machines have drilled all over the world and in all manner of soil and hard rock conditions. We're not afraid to get our hands dirty. We've worked alongside our customers, making crossings on nearly every continent, under the biggest, widest rivers, and under hill and dale. It is this diversity of environments that has taught us what works best in virtually every type of geology. We've taken what we've learned to design and build the best equipment we know how.



Co/ Model	Thrust/ Pullback (lbs)	Spindle Speed (rpm)	Torque (ft-lb)	Pilot Bore OD	Maximum Backream (in.)	Maximum Bore (ft)	Drill Pipe (ft)	Engine HP	Maximum Fluid Pressure (psi)	Flow Rate (gpm)	Fluid Tank (gal)
UNI 12x15	12,000	0-220	1,500	2.25			6	66	1,170	27	
UNI 12x15L	12,000	0-220	1,500	2.25			10	66	1,170	27	
UNI 22x22	22,000	0-220	2,200	3.5			10	99	1,170	27	
UNI 30x40	30,000	0-220	4,000	3.5			10	140	1,000	72	
UNI 36x50	36,000	0-220	5,000	3.5			10/15	175	1,000	72	
UNI 70x90	70,000	0-140	9,000	3.5			15	200	960	188	
UNI 80x100	80,000	0-140	10,000	5			15	200	960	188	
UNI 110x120	110,000	0-140	12,000	5			15	275	840	228	
UNI 160x240	160,000	0-120	24,000	5			20	350	840	228	
UNI 220x240	220,000	0-120	24,000	6			20/30	400	840	228	
UNI 250x400	250,000	0-120	40,000	6			20/30	425			

MAINTENANCE TIP

Our customers bank on our extensive knowledge and expertise when they ask us to build some of the toughest, custom designed machines. And they look to us to teach them how to use the equipment, including how to optimize its performance in the field. We assemble a team from Universal HDD and our valued component suppliers and create a training program as customized as our equipment.

BUY/LEASE TIP

We begin with common platforms, but we engineer and construct horizontal directional drilling machines that meet the specific needs of our customers. Pound-for-pound, at Universal HDD we provide more value to our customers, both in the equipment and customer support.

VERMEER

1210 Vermeer Rd. East
Pella, IA 50219
Ph: (641) 628-3141
Web: *www.vermeer.com*

COMPANY HISTORY

As an industrial and agricultural equipment company, Vermeer Corp. manufactures machines that make a real impact in a progressing world. Vermeer offers customers a full line of high-quality underground construction, surface mining, tree care, environmental and agricultural equipment. Vermeer machines carry a reputation for being built tough, built to perform and built for value. Headquartered in Pella, Iowa, with affiliated companies and independent dealer locations around the world, Vermeer is committed to meeting customers' needs in more than 60 nations. Those customers are at the core of the business and supported by reliable, localized customer service and support provided by independent dealers. That support has been part of the culture at Vermeer for more than six decades. Find more information about Vermeer Corporation, product lines, the dealer network and financing options by visiting vermeer.com.

PRODUCT LINEUP

D6x6 Navigator
D9x13 S3Navigator
D16x20 Series II Navigator
D20x22 Series II Navigator
D24x40 Series II Navigator
D36x50 Series II 10' rod Navigator
D36x50 Series II 15' rod Navigator
D36x50DR Series II Navigator
D60x90 Navigator
D100x140 Navigator
D220x300 Navigator
D330x500 Navigator
D500x500 Navigator
D750x900 Navigator
D1000x900 Navigator
D1320x900 Navigator

PRODUCT HIGHLIGHT

The D9x13 S3 Navigator horizontal directional drill has a 44-hp (32.8 kW) Kubota Tier 4 Final engine, delivering 9,000 lbs (4082.3 kg) of thrust/pullback and 1,300 ft-lbs (1762.5 Nm) of rotational torque. A new hydrostatic hydraulic system for the thrust and rotation circuits increases the system efficiency, al-

VERMEER CONTINUED

Co/ Model	Thrust/ Pullback (lbs)	Spindle Speed (rpm)	Torque (ft-lb)	Pilot Bore OD	Maximum Backream (in.)	Maximum Bore (ft)	Drill Pipe (ft)	Engine HP	Maximum Fluid Pressure (psi)	Flow Rate (gpm)	Fluid Tank (gal)
D6x6	5,500	180	550	N/A	N/A	N/A	6	25	500	5	N/A
D9x13 S3	9,000	190	1,300	N/A	N/A	N/A	6	44	750	15	N/A
D16x20 Series II	19,500	248	2,200	N/A	N/A	N/A	10	65	1,000	25	N/A
D20x22 Series II	20,000	208	2,200	N/A	N/A	N/A	10	94	1,000	25	N/A
D24x40 Series II	24,000	270	4,200	N/A	N/A	N/A	10	125	1,300	50	N/A
D36x50 Series II 10' rod	36,000	227	5,000	N/A	N/A	N/A	10	140	1,300	50	N/A
D36x50 Series II 15' rod	36,000	227	5,000	N/A	N/A	N/A	15	140	1,300	50; 70	N/A
D36x50DR Series II	38,000	210	5,500	N/A	N/A	N/A	10	140	1,100	70	N/A
D60x90	60,000	200	9,000	N/A	N/A	N/A	15	185	1,200	150	N/A
D100x140 15' rod	100,000	203	14,000	N/A	N/A	N/A	15	275	1,100	230	N/A
D100x140 20' rod	100,000	203	14,000	N/A	N/A	N/A	20	275	1,100	230	N/A
D220x300	242,000	164	30,200	N/A	N/A	N/A	20	415	1,200	330	N/A
D330x500	339,600	88	50,700	N/A	N/A	N/A	32	486	N/A	N/A	N/A
D500x500	475,100	36	52,000	N/A	N/A	N/A	32	800	N/A	N/A	N/A
D750x900	786,200	36; 54	99,400	N/A	N/A	N/A	32	800; 1,200; 1,600	N/A	N/A	N/A
D1000x900	985,000	36; 54	99,400	N/A	N/A	N/A	32	800; 1,200; 1,600	N/A	N/A	N/A
D1320x900	1,328,000	36; 54	99,400	N/A	N/A	N/A	32	800; 1,200; 1,600	N/A	N/A	N/A

lowing better use of engine horsepower and increasing the D9x13 S3 productivity. This new hydraulic system also improves the ground drive speed by 60 percent over its predecessor.

MAINTENANCE TIP

Do not overlook daily maintenance points, as they can help maintain the rig's peak performance and reduce premature wear to vital components. Visual inspections are also necessary for identifying potential major service issues before they occur.

BUY/LEASE TIP

The strength and commitment of a manufacturer's after-the-sale support is an important consideration in making a rig purchase decision. Vermeer dealers are always striving to find ways to provide fast, caring service and support. When customers need parts and service, they can count on their local Vermeer dealer.

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HDD USED FOR ENVIRONMENTALLY FRIENDLY PIPE INSTALLATION IN PASCO COUNTY, FLA.

By Charlie Ingram

Like several of its counterparts in Florida, Pasco County is a name frequently repeated in the news when it comes to growth. Founded in 1897 and located just north of Hillsborough County and Tampa, the relatively young Pasco County is approaching a population of 500,000 — spurred in part by a 35 percent increase between 2000 and 2010.

Less known to the public but noteworthy nonetheless, Pasco County Utilities has made headlines in the waterworks industry as a pioneer in the application of horizontal directional drilling (HDD). HDD allows for environmentally friendly pipe installations under wetlands, rivers, creeks, highways, railroad tracks, buildings and other obstacles.

Pasco County Utilities recently tied a record for the longest pullback — or length of pipeline pulled underground — on an installation with AMERICAN Ductile Iron Pipe's 36-in. Flex-Ring pipe. That installation, which went under wetlands, was 1,640 ft in length.

"It was necessary to not disturb the wetlands because they are part of the county's established wildlife corridor that links major environment preservation lands/properties within the county," said Bruce Kennedy, assistant county administrator of utilities for Pasco County. "The wetlands are home to bald cypress, water hickory, maples, oaks, cabbage palms and bay trees with a dense understory of vines, ferns and herbaceous plants. They provide habitat for river otters, deer, squirrels and a variety of birds and snakes."

The record-tying HDD installation in Pasco County was one of three executed under more than 4,000 ft of wetlands during construction of the North Central Reclaimed Water Transmission Main. The other two HDD installations also used AMERICAN Flex-Ring 36-in. ductile iron pipe and saw pullbacks of 1,140 ft and 1,340 ft.

Pasco County is a longtime user of AMERICAN ductile iron pipe and has used it several times on previous HDD pipeline construction jobs. The utility gained experience by initially doing shorter HDD jobs with smaller diameter pipe before taking on larger HDD installations involving 36-in.-diameter pipe. One of those was in 2006 in which the pullback was 940 ft.

According to AMERICAN, the Pasco County project tied a record for the longest pullback on an installation with AMERICAN Ductile Iron Pipe's 36-in. Flex-Ring pipe. The installation was 1,640 ft in length.

That was a record pullback for 36-in.-diameter pipe until the recent installation on the North Central Reclaimed Water Transmission Main, which tied the record of another HDD installation in Meridian, Miss. Both of those installations measured 1,640 ft and both were done with AMERICAN Flex-Ring pipe. In all, Pasco County installed more than 38,000 ft of AMERICAN 36-in. ductile iron pipe as part of the North Central Reclaimed Water Transmission Main.

Pasco County Utilities prefers the strength of ductile iron pipe, and "AMERICAN's Flex-Ring restrained joint is ideal for HDD jobs, because it provides a boltless connection, good joint deflection and ease of assembly," Kennedy said.

Garney Construction Co. was the general contractor for the North Central Reclaimed Water Transmission Main and subcontracted the HDD installations to Cornerstone Businesses Inc., of Zephyrhills, Fla. While Cornerstone had experience pulling smaller diameter flexible restrained joint ductile iron pipe in an HDD application, this project and size of pipe was a first for the company. Cornerstone used a Vermeer 330x500 drill rig, which was suitable for handling the predicted installation load of approximately 110,000 lbs and was much less than the allowable pulling load of 310,000 lbs for the 36-in. Flex-Ring joint.

According to Kennedy, AMERICAN's level of service for the HDD jobs was excellent. "An AMERICAN representative was present for the drilling operations and was very instrumental in providing guidance to the driller. AMERICAN provided the HDD contractor whatever training, guidance and technical support was needed to successfully execute the HDD pulls," Kennedy said.

The pressure that rapid growth puts on a utility's infrastructure is well-documented, and in Pasco County that also applies to the reclaimed water system. That's because Pasco County, which covers 750 sq miles, uses all of its treated effluent through spray irrigation or rapid infiltration basins without any surface water discharge or deep-well alternatives for handling excess wet-weather reclaimed water supplies. All flows must be handled by the reuse system, which consists of two major wastewater treatment plants and interconnecting reclaimed water transmission mains that move reclaimed water between a heavily residential area in one area of the county and an extensive system of rapid infiltration basins in another area.

The North Central Reclaimed Water Transmission Main is a major improvement to that system, which will get another major asset in February 2015 with completion of a 500 million-gal reclaimed water storage reservoir.

Charlie Ingram is a freelance writer, based in Birmingham, Ala.

FUSING PIPE IN FLORIDA

This project involved having a 5,218-ft pipeline pulled 60 ft under the ocean floor

By Susan Hylton

The Florida Keys are a 127-mile chain of small islands that bring a unique geography to Monroe County, Fla. So when it comes to providing thousands of residents and millions of tourists with public services across land and sea, you can't let something as big as an ocean get in your way.

The state of Florida is mandating that a central wastewater system and treatment facility be constructed and completed throughout the Keys by Dec. 31, 2015, to reverse the decline in water quality and deterioration of the coral reefs caused by substandard and outdated sewer systems.

The Florida Keys Aqueduct Authority (FKAA), which provides water services to more than 44,000 customers in the Florida Keys, is currently mitigating the problem along with Monroe County, other municipalities and the state of Florida.

Layne Heavy Civil was awarded the Design-Build contract for the largest segment of the Cudjoe Regional Wastewater Service Area, which includes the Outer Islands Collections and Transmission System for about 5,000 customers on Lower Sugarloaf Key, Ramrod Key, Little Torch Key and Big Pine Key. Layne Christensen Co. is a global water management, construction and drilling company, providing responsible solutions to the world of essential natural resources — water, mineral and energy.

The 5,218 ft HDPE pipeline was pulled 60 ft under the ocean floor connecting Summerland Key to Ramrod Key on the Niles Channel.

PROJECT DETAILS

The project called for a 17-mile transmission system buried along U.S. 1 and a 5,218-ft pipeline pulled 60 ft under the ocean floor to connect Summerland Key to Ramrod Key. Such a feat couldn't have been accomplished without the technological advances in horizontal directional drilling (HDD). Layne hired Utility Services Authority (USA) for the job.

"The colossal task meant that every aspect of the Design-Build project had to be engineered in order to assure safe delivery of the product piping including calculations to determine loading, product pipe selection and thickness, the need for ballast water to offset buoyancy, tensile strength and conformance to the owner's end needs," said USA general manager Chris Lamb. USA is a national utility infrastructure and pipeline contractor specializing in trenchless solutions.

After calculations were done on pipe material and the pipe thickness that would be needed to withstand the depth and pullback force, 18-in. high-density polyethylene (HDPE) DR7 pipe — which was joined together using McElroy's heat fusion machines — was selected.

The tight setup for the drill was a challenge in itself. It was sandwiched at the entrance and exit points between federally-protected mangroves and the Overseas Highway (U.S. 1) during the height of tourist season, which is the only route into and out of the Keys. Each piece of equipment was placed within a very limited, 35-ft wide and 440-ft long drill pad.

USA dealt with weight restrictions on U.S. 1, daytime exclusions on heavy loads and heavy traffic. The contractor also didn't have access to specialized equipment within the remote project area.

"It was like working in another part of the world," Lamb said. "There were literally zero big rig vendors, tool manufacturers or specialized navigators readily available to service us if we experienced an equipment failure. Because of this, we shipped redundant parts and tooling to the project thus eliminating down time and the risk of delaying the job."

USA used its American Augers 625 as the lead rig. Lamb said it was the right fit for the type of drill rod used and could easily accommodate the forces established in the design calculations. The American Augers DD-210 was used for the intersect drill. The pilot hole intersect was completed in just 17 days.

To ensure accurate line and grade, USA installed a redundant grid wire guidance system to cross-check the accuracy of the steering tools in real-time.

FUSING THE PIPE

While this was happening, the nearly mile-long stretch of HDPE pipe was be-

ing heat fused and strung into one continuous piece along the narrow U.S. 1 right-of-way by ISCO Industries using McElroy's MegaMc 1236 butt fusion machine. All together, the project area was about two miles long. McElroy is the leader in the design and manufacture of the industry's most complete line of fusion equipment for joining thermoplastic pipe such as high-density polyethylene (HDPE), fusible PVC and polypropylene (PP).

"The whole fusion process took a great deal of planning in order to install the necessary ballast line within the 18-in. pipe without hindering the ability to fuse and pre-test the pipe," Lamb said.

Once the pilot hole was reamed, the 18-in. pipe was pulled in place with 80,000 lbs of force in one 18-hour shift, ahead of schedule.

Safety and protection of the Keys pristine ecosystem and aquatic life were the biggest concerns throughout the project.

"Prior to the start of the project, soil borings were obtained. This information was used to plan out the best vertical route for the drill path in order to mitigate the possibility of inadvertent returns in the waterway," Lamb said.

The new wastewater project will replace an outdated sewer system in the Keys, which has included cesspits and septic systems in addition to inadequate disposal methods that were not protecting the water and aquatic life that attracts so many people to its shores.

"Reducing nutrient loading to near shore waters expeditiously is important to not only the environment and protection of the reef, but also the Florida Keys tourist-based economy," said FKAA manager of engineering Tom Walker.

Susan Hylton is a public relations specialist for McElroy Mfg., which is based in Tulsa, Okla.

HDD STATS

LENGTH
5,218 ft

DEPTH
80 ft below ground surface (60 ft below channel floor)

GEOTECHNICAL CONDITIONS
Limestone and sand

PIPE SELECTION:
18-in. HDPE DR7

OVERALL PROJECT DURATION (2014)
Mobilized (Jan. 13), drilling began (Jan. 27), pipe pull (March 6) and completion (March 19).

18-in. HDPE pipe was butt fused with McElroy's MegaMc 1236 and staged along U.S. 1.

FLYING HIGH

DCI Continues to Capitalize on Market Potential for HDD Locating

By Andrew Farr

Seattle is perhaps synonymous with innovative companies that display ingenuity in engineering technology. Well, that is aside from Alice in Chains, Starbucks, a lot of rain, a big Space Needle and the reigning Super Bowl champion Seahawks.

But it is fitting that Digital Control Inc. (DCI), an industry leader in electronic guidance tracking for horizontal directional drilling (HDD), is headquartered just south of Seattle in Kent, Wash. The area is closely linked with companies such as Microsoft and Boeing, neither of which are slouches in the engineering department, and DCI, in a way, combines elements from both those companies. As it happens, DCI has its roots in aviation and it's the company's continuous push in software engineering for HDD locating that has kept it at the forefront of the market.

"DCI continues to innovate with new products continuously under development," says company co-founder John Mercer. "One reason we are able to do this is that we have a rich pool of talented people to choose from in the Seattle area. Seattle has spawned many startups and has produced, as well as attracted well-trained people to the area."

After 23 years in business, DCI is continuing to guide the industry into the next era of groundbreaking directional drilling projects by doing what it does best — developing technology that makes the drilling process easier and more efficient.

ROOTED IN AVIATION: PRE-DCI

Digital Control's products have always been based on concepts taken from aviation, which can be traced back to the way Mercer and co-founder Peter Hambling approached the technology due to their background in flying and aeronautical engineering. Today, aviation terminology is still used to describe the movement and position of drill heads during HDD jobs.

Mercer worked for a research company involved in aerodynamics and high-pressure water jet cutting. A different branch of the company had a contract with EPRI to an electric distribution cable replacement device. The device required an existing cable to hydraulically pull itself through the ground cutting a hole using high-pressure water jets. Based on the results of this contract, a new service company called FlowMole was formed to commercialize the device.

In 1984, Mercer was brought into FlowMole, which wanted him to develop a separate device that could install cables without requiring an existing cable. The device Mercer developed was called the GuideDril, which was the start of the modern HDD drills as they are now produced.

"This device was a nearly horizontal drill frame that used keyed drill pipe to push a contoured head through the ground," says Mercer. "The head was designed to contain a dipole transmitter that was tracked using a cable locator. The tracking operator held a paper that had a table relating the depth shown on the locator, which was calibrated for line locating, to the depth of the dipole transmitter."

According to Mercer, the device was really the first of the modern HDD tracking systems. In 1987, Mercer received the first ISTT No-Dig award in London on behalf of FlowMole. Despite success in this area, his time working with FlowMole was Mercer's first introduction to drilling and he still felt unfamiliar with the industry language.

The Right Stuff: DCI founders John Mercer (left) and Peter Hambling with Peter's World War II bomber the two often fly to visit customers. "If we had a business jet, we probably would not get near the attention that we do arriving in a WWII bomber," says Mercer.

DCI's new remote display, the DigiTrak Aurora, is a 10-in. color touchscreen with wireless and Bluetooth connections. The concept of wireless delivery and the ability to add apps make the device easy to upgrade.

"Since I had not been involved in the drilling industry prior to working for FlowMole and had an aeronautical background, I found the drilling orientation terms awkward," he says. "I replaced the drilling terms: tool-face angle, elevation and azimuth with the equivalent aeronautical terms: roll, pitch and yaw. These terms remain today with the HDD industry.

"In designing the steering head of the boring tool, I saw great similarity between the earth forces on the head and the aerodynamic forces on a body at hypersonic speeds. When people asked why I left aerodynamics for drilling, I would say the drilling is really teradynamics and I saw a lot of similarity."

Mercer left FlowMole in 1988 with the goal of developing a more efficient locator. While FlowMole's model had been a targeted HDD locator, the design was still based on cable locating principles.

"I wanted to design a locator specifically for HDD," he says. "The main problems with the cable locating technology were the ghost signals that often confused operators and caused cables to be installed at shallower depths than specified and the lack of depth accuracy as the bore became deeper. I also wanted to eliminate the fragile keyed drill rod used to determine roll orientation and I wanted to provide the locating operator with pitch. Holding a drill level was one of the most difficult tasks to train an operator and I knew that knowing pitch would make the training go much faster."

Knowing it would take more than just ideas and a basic design to model, Mercer contacted his friend Peter Hambling for help. Hambling, who has a master's degree in aeronautical engineering, was working at the time for Orbital Sciences, a company working on putting commercial satellites into orbit. Hambling joined Mercer in January 1991 and Digital Control Inc., began selling its first product in August of that year.

TARGET STEERING AND NEWER MODELS

Digital Control's first product was an immediate success as productivity increased drastically, cable locators faded from the market and digital locating of drill heads became the new standard. From there, the company continued to improve upon early models, one of which included incorporating a radar screen look into a new locator, called the Eclipse. With this model, the boring tool's transmitter location underground was shown like a blip on a radar screen so that the operator could walk directly to the target.

The Eclipse paved the way for what would become a major milestone in digital locating for the company — the introduction of Target Steering. Target Steering comes into play most often when a drilling job encounters a road or river crossing in which it isn't possible for a crewmember to walk a locator ahead of the drill head. With Target Steering, the operator programs a desired depth into the locator, places it on the bore path in front of the drill head, and the drill operator then steers directly to the desired position below the locator.

Over the years, DCI's transmitters and handheld devices have continued to evolve. In addition to transmitting the pitch, roll and depth of a drill head, transmitters are also capable of relaying temperature and even fluid pressure.

One of the company's new remote displays, the DigiTrak Aurora, is a remote device that includes wireless and Bluetooth connections and is the company's first remote device to feature a color touchscreen interface. Continuing to advance this technology has been the hard work of longtime employees who have taken Mercer and Hambling's ideas to the next level. Introducing DCI's new products to market falls on the company's sales and marketing team, including product manager Siggi Finnsson.

"This device (Aurora) is specifically aimed at being extensible," says Finnsson, who has worked at DCI for 19 years. "So as we come up with clever ways of displaying data differently, [information] will be delivered in forms of applica-

tions rather than getting a new device or a completely new software upgrade."

The concept of "apps" and wireless delivery makes it easy for Aurora to be upgraded and evolve. Aurora also allows the user to set alarms, or threshold points, to alert an operator when the drill head has reached a certain position or when temperature and pressure have reached certain levels. These alarms lower the number of things a drill operator must actively monitor while on a job.

KEYS TO MARKET LEADERSHIP

According to Finnsson, DCI doesn't tend to think of itself as competing with other manufacturers of HDD locating devices in the industry, but rather with the innovative technology in any industry.

"Although all [trenchless] companies are moving the ball forward, we tend to think that on this fairly narrow stage of HDD locating, we tend to do more of it than most," he says. "I think that one of the key things we do differently than really anybody else, is that we have focused only on HDD locating. We don't have other products or other lines that compete with the locating. So anything and everything we do from a research standpoint is focused on advancing that state of the art."

Finnsson says the company also has extensive experience in its personnel, who are invaluable in helping the company solve problems and continuing to move the business into the future.

"Being in Seattle, we also have access to some exceedingly well-qualified engineers," he says. "There are ex-Microsoft people at DCI, there are ex-Boeing people at DCI. Not to put too much emphasis on engineering, but it does start with hiring the most capable people.

"It's a constant challenge as we get more sophisticated, to keep the technology operational," he adds. "One challenge that we've really been focusing on is the ability to simplify. Ease of use and ease of training has been a huge focus, and that's a challenge to take complex things and present them in such a way that they're simple."

DCI TODAY

These days, John Mercer and Peter Hambling, who also holds the title of company president, are still very much active in company operations. Mercer's son, Matt, is also involved in the business while the elder Mercer spends the majority of his time with a new company that works on developing automatic pilot systems for helicopters.

Although maybe not what they expected when they began their careers in aviation, Mercer and Hambling are proud of what they've been able to accomplish in the directional drilling market. They've even continued their love of flying as they occasionally use Hambling's World War II bomber to visit customers.

"If we had a business jet, we probably would not get near the attention that we do arriving in a WWII bomber," says Mercer. "Peter and I have aeronautical backgrounds and we both love flying, we also love innovation. HDD has allowed us to be innovators and do well at it."

Andrew Farr is associate editor of *Trenchless Technology*.

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HDD IN CALIFORNIA

Contractor Experiences Changes in Pipe Size and Project Length but Still Completes Job on Time

By Jeri Lamerton

The job began as a relatively straightforward directionally drilled creek crossing to install 600 ft of steel gas pipe. However, a change in the size of pipe, unexpected site restrictions, difficult soil conditions, and limited hours to work made this project far from routine.

Exactly the type of project suited for California contractor Accu-Bore Directional Drilling, an experienced horizontal directional drilling contractor that also provides engineering services and complete turnkey and design-build capabilities.

The creek crossing originally was a 620-ft long project to replace a 6,693-ft long segment of old distribution line in Graton, a rural area 60 miles north of San Francisco. Project owner was Pacific Gas & Electric (PG&E), a long-time client of Accu-Bore.

Accu-Bore pulled its 100,000-lb pullback JT100 working south of Los Angeles so it could be used on this crossing, 60 miles north of San Francisco.

CHOOSING HDD

PG&E's plan was to open-cut everything but the creek crossing, which is in an environmentally-sensitive area, said Accu-Bore general superintendent of operations Erich Metzger.

"However," said Metzger, "after consulting with PG&E about the entire project, we agreed it made sense to use horizontal directional drilling (HDD) to install another 3,375 ft of the project. This was done to speed production, minimize the environmental impact, and reduce restoration."

Before construction started, PG&E determined that the size of the casing pipe needed to be enlarged from 10 to 12 in.in diameter.

"That changed the parameters of the creek bore," said Metzger. "Because of our established relationship with PG&E, the company was comfortable with us redesigning the bore. Accu-Bore president and CEO Michael Robirds, P.E., redesigned the bore, adding greater setbacks for the drill unit to provide the necessary grade to attain the required depth of below the creek bottom. The length of the bore was doubled to 1,200 ft."

PROJECT DEADLINE COMPLICATIONS

Deadline to complete the installation was Dec. 24. On Dec. 13, a Ditch Witch 40,000-lb pullback JT4020 AT drill unit launched the pilot hole from a setup spot on the highway south of the creek. The hydraulically driven dual pipe AT (All Terrain) drilling system is designed for rock and hard formations. Patrick Lannoo was crew chief.

As work got under way, PG&E and Accu-Bore were notified by the California Department of Transportation (Caltrans) that work must be limited to the hours between 9 a.m. and 3 p.m. because both lanes of the two-lane state highway had to be open for morning and afternoon work traffic.

With an already-tight deadline, clearly this unexpected news would complicate the project.

Soil at the launch point was chunky rock, said Metzger. Under the creek, it became soft and difficult to steer. Drilling fluids escaping from the borehole had to be contained to prevent it spreading to the environmentally-protected area Accu-Bore kept its 120-barrel vacuum tanker onsite, along with another sub-hauler. The disposal site was approximately 80 miles away.

The pilot hole was completed in one shot in four days.The first reaming pass was started on Dec. 16 using the JT4020 AT that drilled the pilot hole.

"After several passes it became clear that in these soil conditions multiple reaming passes would take far too long with this equipment to meet the Dec. 24 deadline," Metzger said. "And we knew in these soil conditions the hole would not stay open until after the Christmas holiday — pipe had to go in the ground immediately. A larger machine was needed."

Accu-Bore had a 100,000-lb pullback JT100 working south of Los Angeles.The decision was made to pull it off that job and bring it to the creek crossing site to complete the backreaming and pull in the new pipe.

"We had to demobilize the JT100 and bring it 600 miles north, and swap it out with the smaller machine," Metzger said.

"On Dec. 20, we began reaming with an 18-in. hole opener. We had to complete reaming and pipe installation and be off the road in four days."

EARLY START, MORE BORES

To help speed up the work, Caltrans had allowed Accu-Bore to begin work on Sunday, rather than Monday morning.

During backreaming, PG&E crews staged pipe on the highway right of way adjacent to the pilot hole exit pit. Pipe was assembled in three strings of 360 ft each.

"We began pulling in the casing at midnight on the Dec. 24, completed it by 4 a.m., and cleared the work area by 6:30 a.m., said Metzger. "Our crew came back after the holiday to complete the demobilization."

In addition to the creek crossing, seven other bores and pullbacks of approximately 500 ft each were made on the project.

"This project is a good example of the solutions-based delivery of services clients receive from Accu-Bore," said Metzger. "If a problem surfaces, the solution is not just to throw resources at it, but employ the right resources. In order to work, there must be mutual trust and that enables both parties to achieve shared goals of finishing on time and on budget, no matter what contingencies must be used to overcome unexpected situations."

The project was originally designed for just 620 ft but eventually included another 3,375 ft to be directionally drilled.

Accu-Bore was established in 2005 by Billy Kilmer Jr. — now chief operating officer — with one drilling rig and three employees. By 2010, the growing company had more than 20 employees and seven drill units. That year, Accu-Bore merged with engineer Mike Robirds' company, MDPR. Continuing to do business as Accu-Bore, the company today typically has 11 drill units in the field on any given day.

Metzger said the company's clients primarily are utility companies. Accu-Bore helps address complex utility issues in the areas of water, wastewater, natural gas, electrical, and communications. Services include horizontal directional drilling, utility locating, CCTV pipe inspection, and design and turnkey construction services.

Jeri Lamerton is public relations manager for The Charles Machine Works, Perry, Okla.

WHERE THERE'S A WILL, THERE'S A WAY

Treacherous terrain, layers of rock and a cavernous river crossing — all in one continuous bore — tested the trenchless skills of an Arkansas underground contractor.

By Randy Happel

If Ronald Cline was the type to back away from a challenge, it's entirely possible that a natural gas gathering line, now securely in place in central Arkansas, would likely not have been installed underground.

But this conscientious and ingenious native Razorback devised a trenchless approach that resulted in the successful completion of a continuous bore amid some of Arkansas' most treacherous terrain, and through some of the state's toughest and trickiest rock.

More than 56 percent of the state — some 18.720 million acres — is forest land, characterized by steep cliffs of varying layers of hard rock, with hundreds of clear streams and rushing rivers nestled within. Suffice it to say that Little Rock, the Arkansas state capital, is most appropriately named.

Cline, owner and president of Cline Trenching, headquartered in Bono, Ark., just outside the City of Jonesboro (pop. 67,000), started his company more than a quarter century ago. In the early days — with assistance of an older-model used trencher — he got by installing water lines and digging house footings. Today, more than 25 years later, Cline Trenching has nearly 30 employees, and a loyal customer base that resembles a who's who of energy and communications companies; including AT&T, Center Point Energy and Crestwood Midstream Partners — just to name a few.

The company specializes in pipeline, fiber and, given the abundance of the hard stuff throughout the state, rock quarrying. Cline is personally present on every jobsite — in the trenches working right alongside his crews, in addition to supervising their progress.

"I'm on the job every day and still involved with all aspects, from actual drilling to day-to-day operations," Cline says. "I think my hands-on involvement, and the fact that my crews see me working as hard as I expect them to work, motivates them to do their best. We do quality work; and we do it on time. I tell my guys, 'It's not how much we get done today, but what we do get done has got to be done right.' My word is good; and our customers know that."

The drill plan specified a continuous bore of 1,170 ft that included a 100-ft underground river crossing — at a depth of 150 ft — approximately 480 ft into the route. Cline Trenching used a Vermeer D80x100 Series II drill.

ONE BORE, MULTIPLE OBSTACLES

Longtime customer Crestwood Midstream Partners, headquartered in Houston, approached Cline about installing a natural gas gathering pipeline through the heart of Arkansas' rugged, rocky terrain. The job involved installing a 12-in. steel line using horizontal directional drilling (HDD), through some of the hardest, most unpredictable layers of rock in the country; conditions all too familiar to Cline and crew.

Cline was confident that his Vermeer D80x100 Series II Navigator horizontal directional drill could handle the rock, as proven many times before. The only hesitance was his ability to provide Crestwood with an accurate cost estimate.

"At first I told them [Crestwood] this probably was not the job for me," Cline says. "I knew the Vermeer drill was capable of completing a bore of that length and in those conditions. But it was difficult to estimate with a lot of certainly the amount of time it would take, given all the unpredictable variables. We really hadn't completed a continuous bore combining all those obstacles and challenges before."

But Crestwood was persistent. Cline had always been their contractor of choice on jobs located within reason-

able distance of his home base. And because the good folks with Crestwood were well aware of the complexity of the bore, they really wanted Cline to be the one to handle it. Yet before committing, Cline consulted with his sales representative at Vermeer Heartland, based in Murfreesboro, Tenn., for an objective perspective. After their conversation, Cline decided to accept.

"I have as much experience with the conditions here in Arkansas as anybody," Cline says. "And I didn't want to put a loyal customer in a bad situation with a contractor from outside the area who was not familiar with the conditions. The rock here in Arkansas is different than anywhere else. I've seen contractors from outside come in here unprepared, low-ball their price; then pack up and leave. I didn't want to see that happen to Crestwood. They trusted us to complete the job as quickly and efficiently as possible. The upfront bid didn't matter; they just knew we'd get the job done right."

CHALLENGE NO. 1 — *CADRON CREEK*

In devising his drill plan, Cline started by taking GPS readings; first to the bottom of Cadron Creek — a popular scenic paddling stream that flows in a westerly direction from its origin near Heber Springs in central Arkansas — followed by a second reading at the site where the Vermeer drill would be positioned. Measurements from the edge of the creek up the side of the hill toward the drill site were then registered so Cline's crews could accurately calculate drilling depths and distances.

Bordered by fields, farmsteads, bluffs and canyons, the majority of the 59-mile-long Cadron Creek lies out of sight, quietly nestled more than 140 ft below the horizon. While the rocky shoals and rugged bluffs on each side create spectacular scenery for paddlers, the sharp drop and subsequent steep incline in elevation from the drill's launch site — necessary to hit the exit target — wasn't all that pretty of a picture for Cline.

"What really made the bore difficult was the elevation change created by the creek," Cline says. "The drill plan required the depth of the bore drop quickly within a relatively short distance to make the underground creek crossing; followed by a sharp 110-ft incline to make the target. Also, keep in mind this was one continuous bore; through multiple layers of hard rock, in a dense forest. It was a very complicated job."

CHALLENGE NO. 2 — *THE ROCK*

Drilling through solid rock is one thing; drilling through varying layers of solid rock with areas of void in-between the layers is something altogether different. Having encountered layered rock formations previously, Cline and crew knew how to best prepare.

"The rock here consists of hundreds of layers of different types and varying

densities," Cline says. "To further complicate the situation, there are voids, cracks and spaces between the solid rock layers. Few drilling conditions are as unpredictable as boring through Arkansas rock.

"Cement is the remedy," Cline says. "Once you start losing an extraordinary amount of drilling fluid, you know you're drilling through a void. Pumping cement into the area fills the void. After the cement sets up and hardens, it functions like soft rock and drilling can continue. The cement prohibits additional drilling fluid from escaping."

This was the fourth jobsite where Cline's crews were required to pump cement into the void between rock layers to better secure the bore path and restrict the loss of drilling fluid. It was the first occasion, however, where it was necessary to add cement at four different points.

"Normally you pump in one spot, drill through it and just complete the job," Cline says. "We pumped in four places on this project. We would drill for a ways, hit a void, start losing fluids, pump cement in and let it set, then go back and drill through the cement. We repeated this process four times. It really affected our production rates. It had nothing to do with the capabilities of the drill; it was all about the conditions, which is what I was concerned about before I agreed to take on the job."

CHALLENGE NO. 3 — *ROCK REAMING*

Having been involved in HDD since the trenchless installation method was first introduced, and his trade territory is situated near some of the hardest, most complicated rock in the country, Cline has learned a thing or two about tooling; specifically, reamers. Early on, he had some frustrations was with what he considered to be inefficient reamer tooling — especially for boring through rock. "Upsizing capacity for reamers then was limited to 2 to 3 in. per ream; often requiring multiple passes for a single bore. Most reamers were also hard on equipment, and a tendency to steer off course," he says.

So Cline got proactive.

"I wanted a reamer that would take out no less than 5 in. of material on a single pass and easier on equipment," Cline says. "We worked on a design change by increasing the size of the rollers situated on the front and back of the hole opener. Consequently, on this job, instead of having to ream multiple times, we reamed one time with the new larger roller design. It's a design approach that we've found to be highly successful and more efficient."

ALL'S WELL THAT ENDS WELL …

Rarely does any contractor face such diverse and demanding — not to mention unpredictable — circumstances; as underscored by the fact that it took Cline more than three months to successfully complete the 1,170-ft bore; a length that under "normal" circumstances, would likely have taken less than 30 days.

Halfway through the bore, the body of the mud motor Cline was using wore out; forcing him to pull back and replace it in mid-bore. It took five drill bits to complete the bore, and five 18-in. reamers. And despite having lost location of the drill head on three separate occasions, Cline's crew emerged on the exit side within 30 in. of their target — a testament to the skill, experience and diligence of his drill operators and supporting cast of underground experts.

"I believe in buying the best equipment and hiring the best crews available," Cline says. "When the guys go out to do a job, they're able to do it without having very many breakdowns. Our Vermeer drill has been a very reliable, capable piece of machinery. But we also take good care of our equipment and make sure it's properly serviced. Equipment that's properly cared for will always take care of you.

"The other thing is that we're all about the environment," Cline says. "We try to make everything look just like it did before we arrived on-site. All around, everything we do, we try to do it the best that we can. Just pretend like you're doing it for the good Lord and he is always looking over your shoulder."

Randy Happel is a freelance writer from Des Moines, Iowa.

The project involved installing a 12-in. steel line using horizontal directional drilling through some of the hardest, most unpredictable layers of rock in the country.

DRILLING FLUID MANAGEMENT DURING HORIZONTAL DIRECTIONAL DRILLING

By Ali Rostami1, Yaolin Yi, PhD2, Ali Bayat, PhD, PEng3, Manley Osbak4

1 Phd Student, Department of Civil and Environmental Engineering, University of Alberta
2 Postdoctoral Fellow, Department of Civil and Environmental Engineering, University of Alberta
3 Assistant Professor, Department of Civil and Environmental Engineering, University of Alberta
4 Vice President Engineering and Estimation, The Crossing Company, Alberta, Canada

Horizontal Directional Drilling (HDD) is a trenchless construction solution to traditional open-cut methods used for utility conduit installation. Over the past four decades, advancements in HDD have made it an effective and common installation method, particularly in congested urban areas and environmentally sensitive areas, such as beneath rivers and wetlands, as it minimally impacts surroundings. The HDD process includes pilot boring, reaming, and product pullback.

Drilling fluid is used in all the three stages of HDD, functioning to: provide stability to the borehole, especially in collapsible soil and porous medium; decrease the frictional drag between the pipe and the borehole; cool the drill bit during excavation, and transport drill cuttings to the ground surface. Drilling fluid generally comprises an admixture of water and bentonite, and different types of additive can also be used to improve the fluid's capacity to carry the cutting soils out of the borehole. Figure 1 shows the first stage of HDD in which the borehole is excavated with a mechanical cutting structure and the cutting soils are transported to the ground surface by means of hydraulic transmission (circulation of drilling fluid).

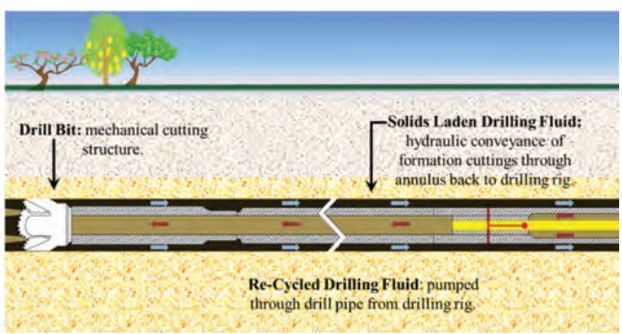

Figure 1. Mechanical cutting of the borehole in the first stage

The drilling fluid pressure in the borehole must be high enough to provide borehole stability and adequate circulating pressure for cutting transport out of the borehole. However, excessively high drilling fluid pressure can also cause hydraulic fracture and release of drilling fluid to the ground surface, which is a critical issue encountered during HDD. This phenomenon occurs when drilling fluid pressure exceeds the shear strength of the surrounding soil, which causes cracks to propagate to the ground surface. Penetration of the drilling fluid into the cracks leads to operational (loss of drilling fluid, collapse of the borehole, bit balling, and circulating pressure loss) and negative environmental impacts. Figure 2 illustrates the growth of the crack around the borehole during pilot boring. Hydraulic fracture is the greatest concern in the first stage of the boring process, as it has lower annulus areas compared to the reaming stage. Therefore, higher interaction between drilling fluid particles in lower annulus areas causes an increase in annular pressure.

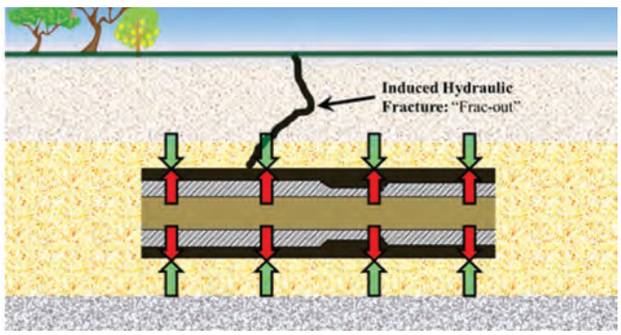

Figure 2. Hydraulic fracture

DRILLING FLUID MANAGEMENT

Drilling fluid management is a technique employed during HDD to maintain a proper drilling fluid pressure, which prevents mud loss failure and provides stability through the borehole. HDD contractors and engineers should consider applying a drilling fluid management system to achieve a targeted drilling fluid rheology and to predict the mechanical behavior of drilling fluid as it interacts with soil in the borehole. Effective drilling fluid management provides the necessary information to monitor and control risk events resulting from elevated annular pressures during HDD construction. To accomplish this, the circulating drilling fluid pressure (plan pressure) must be predicted, which can be done via the appropriate flow model and associated parameters.

Annular pressure is comprised of friction loss and hydrostatic pressure. During borehole excavation in HDD operations, the annular pressure is determined based on the total pump output rate, annular space within the borehole, and drilling fluid properties. When the pump is off and circulation stops, the hydrostatic pressure remains within the borehole annulus. When pumping resumes, the fluid flows through the annulus. Hydrostatic pressure is equal to mud column weight through the borehole, and friction loss pressure is calculated through rheological models, such as Newtonian, Bingham Plastic and Power Law models. Figure 3 shows the mechanical behaviour of each rheological model.

The relationship between shear stress/shear rates of the drilling fluid can be determined by using the viscometer. A viscometer is an instrument used to determine the rheological parameters of drilling fluids based on the shear stress (torque) and

the shear rate (RPM). The Fann Model 35 (designed by Fann Instrument Company), a six-speed viscometer (3, 6, 100, 200, 300, 600 RPM), can be used to extract the plastic viscosity and yield point of the drilling fluids (Figure 3). Although the two-speed viscometer (300 and 600 RPM) is commonly used in HDD industry, it does not measure the shear stress within the range that corresponds to annular flow velocities in HDD. Therefore, the six-speed viscometer is recommended to measure sheer stress at appropriate speeds, the impact of entrained solids, and the carrying capacity or gel strength.

The Bingham Plastic model is commonly used to calculate drilling fluid pressures within a borehole. It accounts for the yield stress of laminar drilling fluids but overestimates the shear stress for lower shear rates (Figure 3) as shear stresses are based on shear rates of 300 and 600 RPM. As a result, the drilling fluid pressure derived from the Bingham Plastic model is overly conservative, which can lead to deeper and longer drill path designs, thereby increasing overall construction costs.

According to American Petroleum Institute Recommended Practice (API RP 13D) 2009, the Power Law model (Pseudoplastic) is considered the standard model for calculating drilling fluid pressure within the borehole. This method is more desirable for drilling fluid as it accounts for the nonlinear relationship between the shear stress and shear rate (shear thinning behavior). The API RP 13D (2009) recommends shear rates of 100 RPM and 3 RPM to determine the annular pressure profile across the drill path.

By assuming the drilling fluid density (ρ in pound per gallon (ppg), the gradient of the friction loss pressure in psi/ft can be calculated by using the following formula:

$$\left(\frac{dP}{dL}\right)=\frac{f_a V_a^2 \rho}{25.81\left(D_2-D_1\right)}$$

In which, D1 and D2 are the borehole diameter and the drill pipe diameter respectively, Va is the velocity, and fa is the friction factor which is calculated by using the following equation:

$$f_a=\frac{24}{N_{\mathrm{Re}_a}}$$

The Reynolds number NRea in the annulus is calculated as follows:

$$N_{\mathrm{Re}_a}=\frac{928\left(D_2-D_1\right)V_a\rho}{\mu_{ea}}$$

The effective viscosity (μea) is the viscosity of the flowing fluid in specific geometry depending on the annulus diameter and Power Law indices (Ka and na). The effective viscosity is calculated as follows:

$$\mu_{ea}=100\ K_a\left(\frac{144V_a}{D_2-D_1}\right)^{n_a-1}\left(\frac{2n_a+1}{3n_a}\right)^{n_a}$$

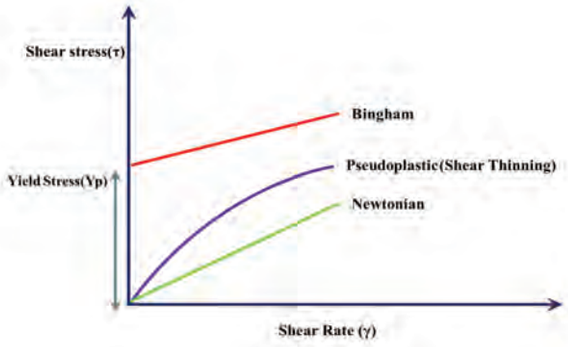

Figure 3. Mechanical behavior of different rheological models

Drilling Fluid Density, ρ (kg/m^3)	1060
Viscometer Readings (degree of Fann):	
θ_{600}	48
θ_{300}	44
θ_{200}	38
θ_{100}	34
θ_{6}	23
θ_{3}	22
Funnel Viscosity (s)	72

Table 1. Rheological Properties

CASE STUDY

A case study is presented to investigate the applicability of the Power Law model to calculate the plan pressure for drilling fluid management during pilot boring. The length of the investigated crossing is 1,800 ft with a pilot bit diameter of 12 ¼ in. and a drill pipe diameter of 5 ½ in. (Figure 4). The annular pressure measurements used in the assessment were made while running into the predrilled and clean borehole annulus within the pilot hole. Due to the presence of bentonitic mudstone, the drilling fluid system comprised water and bentonite with polymer additives.

The drilling fluid rheology was measured using a Fann 35 rotating viscometer in different drill locations to improve the annular pressure prediction result. The average measured rheological properties during drilling have been summarized in Table 1.

The annular pressure measured during pilot drilling has been compared with the results predicted using Power Law model, as shown in Figure 5. Any deviation of the drilling fluid pressure from the plan pressure during boring indicates abnormal downhole conditions. An increase in annular pressure can arise, possibly from cutting-bed development at the bottom of the borehole during drilling or from mud rings during excavation through cohesive or granular soils. A loss of drilling fluid pressure may also occur due to frac-out around the borehole.

Figure 5 illustrates how plan pressure and annular pressure measurement comparison can reveal downhole conditions which can be used to evaluate risk such as frac-out. By following the plan pressure (predicted pressure), contractors can reduce the risk of increased annular pressure and frac-out during drilling. In this case study, the annular measurements correspond to data gathered before cleaning and gauging the borehole. The solid line in Figure 5 corresponds to the annular measurements taken during the drilling of the pilot hole before moving the drilling assembly backward to clean the borehole, while the dashed line indicates the pressure predicted by the Power Law model.

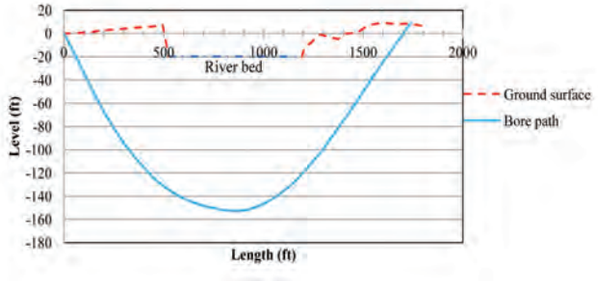

Figure 4. Longitudinal profile of bore path

As seen in Figure 5, the circulating pressure diverged from the plan pressure at 200 ft, which indicates buildup of cutting soils at the bottom of the borehole. To prevent the increase of circulating pressure, the drill bit was pulled back to the entry pit to clean and gauge the borehole. The borehole was cleaned and

gauged five times following the original cleaning a 200 ft (Figure 5). After 650 ft, the cutting-bed developed again, and the annular pressure increased. The drill bit then returned to a lower depth to transfer cutting soils to the ground surface and then advanced further into the hole. Each time the borehole was cleaned, the annular pressure dropped to correspond with the predicted pressure. If collapse or expansion of the borehole wall occurred, the annular measurements did not match the predicted pressure. Figure 5 indicates that the Power Law model is capable of closely predicting the measured annular pressure following each instance the borehole is cleaned. Therefore, drilling fluid management could be used as an effective tool to help develop cost-effective designs and to decrease the risk of negative environmental impacts.

REMARKS

Updating the drilling fluid's rheological parameters can provide a more realistic assessment of the annular pressure as hydraulic parameters exhibit time-dependent behavior during HDD operations. Comparing annular measurements with the Power Law model indicated that using the model with the shear rate ranges of 100-3 RPM suggested by API RP 13D (2009) can approximate the drilling fluid pressure sufficiently.

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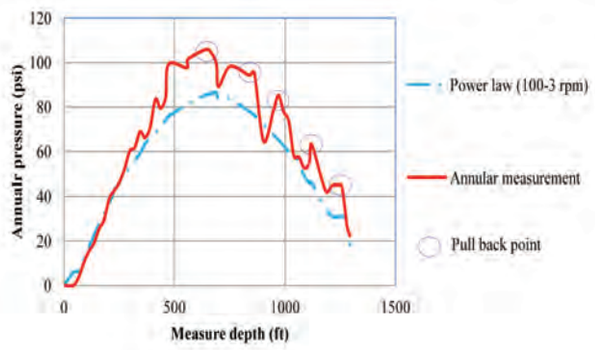
Ali Rostami, is a Phd student, in the Department of Civil and Environmental Engineering, at University of Alberta

Yaolin Yi is a postdoctoral fellow in the Department of Civil and Environmental Engineering, at the University of Alberta

Ali Bayat is an assistant professor in the Department of Civil and Environmental Engineering, at the University of Alberta

Manley Osbak is vice president of engineering and estimation at The Crossing Company, Alberta, Canada

Figure 5. Annular pressure graph



PRODUCTS

AMERICAN AUGERS

American Augers introduces its MCD-1000 mud system, boasting the best cleaning capacity in the industry. This high volume reclaimer reduces volume of solids by controlling the overall moisture content which leads to easier fluid disposal. It has a cleaning capacity of 1,000 gpm and utilizes Derrick Equipment Shakers. The state-of-the-art Krebs gMax desilting hydrocones produce finer, sharper particle separations at high capacities.

ARMADRILLCO

Designed for the HDD market, the Arma Drillo High Flow Transmitter Housing, features a secure sealed Sideload Transmitter Cavity with 48 variable clock positions, universal API threads, and accommodates common transmitters. Not only does the Transmitter Cavity insulate the transmitter from excessive vibration and heat, but it also seals out the compacted soils, sands, and grit. Mechanically and chemically bonded urethane is used to seal each slot. Lock pins held in by sacrificial O-rings insure that the door will not open downhole. Can be used with Mud Motors,Air Hammers, Roller Cone and Bullet Tooth Bits. If you want versatility in a tough package that can deliver results, try our Arma Drillo transmitter housing. It's the solution to help prevent your electronics from being destroyed by excessive heat and vibration. Dealers include: INROCK Inc., Drillhead Inc., Georgia Underground, Specialty Drilling Tools Inc., and in Australia, Dilong Drilling Services.

ATLAS COPCO

The Klaw hole opener from Atlas Copco Secoroc is based on the patented Klaw technology proven successful in blasthole drilling in soft rock applications. A one-piece 4140 alloy steel bit body provides complete blade and body strength. Stabilizer pads center the hole opener in the pilot bore, and 3D-designed cutter locations and bit features are CNC machined to meet exact design specifications and ensure product repeatability. The Atlas Copco Secoroc Klaw hole opener provides higher penetration rates, efficient cleaning of bore, smoother drilling and longer lasting bits.

BAROID INDUSTRIAL DRILLING PRODUCTS

Baroid Industrial Drilling Products is expanding its line of highly dispersible products. POLY-BORETM a high molecular weight PHPA polymer already well known in the industry will be upgraded. This new dispersible product makes for easy mixing and application in the HDD industry. POLY-BORE polymer will continue to aid in maintaining a stable borehole by inhibiting reactive clay and shale formations along with being non-fermenting and NSF certified.

BJM PUMPS

The KZN heavy duty submersible agitator pumps are designed to tackle the toughest conditions, including heavy slurries containing lime, mill scale, coal, ash, silt, food waste or sand and gravel. The impeller, wear plate and agitator are made of abrasive-resistant, 28 percent chrome iron (600 Brinell, 57 Rockwell C). The agitator can easily put heavy solids into suspension and be pumped away with the liquid, preventing clogging. The replaceable wear plate's hardened surface on the suction side prevents erosion, which would typically cause a loss of pump performance. The semi-open Impeller can handle abrasive solid concentrations as high as 70 percent by weight. All of the KZN series pumps have a top discharge and slim design, which allows them to fit into tighter and thin spaces. Every KZN slurry pump model is protected by Class H motor insulation and built in amperage (FLA) and temperature overload protection. It also has double silicon carbide mechanical seals in a separate oil filled seal chamber and a heavy duty lip seal. The stainless steel shaft and shaft sleeve also saves on shaft wear due to abrasives and corrosion. The pumps volutes, cast from hardened Ductile Iron (300 Brinnell hardness), are twice as abrasive resistant as standard ductile iron and cast with extra thick walls at the point where the pumped slurry enters the discharge. They can also pump a sump or pit down to within inches of the bottom.

CCI INC.

Since 2004, CCI Inc. has been the "go-to" company providing award-winning services to the oil and gas industry and specializes in designing, building and maintaining trenchless crossings — the highest risk part of a pipeline crossings project. To ensure success and enable clients' continued social license to operate, CCI has introduced PIPE-360, an innovative tool that assists with current and future pipeline project planning. A "360-degree" approach is followed through each phase of a project, including: data gathering, field assessments and desktop evaluations, construction execution and monitoring, post-project review and data management, and long

term monitoring and compliance. The process involves an in-depth analysis by a multi-disciplinary team of experts including engineers, geologists, geotechnical specialists, construction pros, foresters and biologists. Work can be completed by CCI's specialists, or by the client's designates. An app is being developed to enable any company to export its data and perform similar analyses.

CENTURY PRODUCTS

Century's Gold and Falcon Series Hole Openers have a proven track record for high penetration rates with the reliability customers have come to expect. Engineered specifically to withstand the extreme forces encountered underground, every Century Hole Opener incorporates the largest cones possible, allowing for a reduced Revolution Ratio which increases the life of the bearings and seal. This allows the Hole Openers to remain in the hole longer reducing your overall drilling costs. When soil conditions do not require a rock Hole Opener, we have a full line of Fly Cutters and Barrel Reamers made to customer's specifications. Built with the same high quality standards, these reamers incorporate replaceable carbide teeth and replaceable carbide jets which enhance the cutting action of the tool. In addition to these Hole Opening tools, we offer made in the USA, Tri-Cone Bits, 3 7/8 to 12 ¼ in., incorporating the same down-hole features that keep them drilling longer.

DERRICK EQUIPMENT

Backed by more than 60 years of cost-effective solutions, plus award-winning customer support, the Derrick Hyperpool shaker is the latest in a long line of products designed expressly to exceed the demanding needs of today's drilling operations. With its compact footprint, industry-leading processing capacity, and low maintenance cost, the Hyperpool is well suited for all drilling applications where drilling performance and rig modularity are required. The Hyperpool is designed to bring maximum value to the operator.

DIRECT HORIZONTAL

Direct Horizontal Drilling is Canada's premier horizontal directional drilling contractor with an extensive fleet of drilling rigs, an excellent team of knowledgeable and dependable people and the most successful history of river crossings in Canada. Direct Horizontal operates from coast to coast, headquartered out of Edmonton, Alberta, and field locations throughout Western Canada. Direct Horizontal equipment and crews have extensive experience operating in extreme weather conditions. Direct Horizontal's custom built rigs provide customers efficiency in horizontal drilling and is considered by customers to be the best high-tech rig in the industry today.

DITCH WITCH

Designed for the underground utility contractor, the Ditch Witch JT25 HDD offers 27,000 lbs of thrust and pullback, an exclusive rotational drive with 4,000 ft-lbs of torque, and the industry's quietest mid-size drill operation. It is ideal for installing utility pipe and cables of up to 12 in. in diameter at lengths of up to 500 ft. Featuring a 130-hp, Tier 4i Cummins diesel engine, the durable JT25 is a workhorse designed for low-maintenance, high-quality performance.

E&M SUPPLY GROUP LLC

E&M's 5 ½-in. FH DOUBLE SHOULDER- the single most popular drill stem for maxi rigs larger than 300,000 lbs. E&M SUPPLY GROUP has a premium used string of this pipe available for sale at its Breaux Bridge, La., facility. This pipe is rare and hard to come by.

The majority of premium 5 ½ in. that comes into the market is standard FH, not double shoulder. HDD operators prefer double shoulder because it offers 30 percent more torsional strength than standard FH, and because it is more resistant to over-torque. If you are using 5 ½-in. FH and you have more than 72,000 ft-lbs of torque, then 5 ½-in. double shoulder is the way to go. Please call (337) 332-0239 or email brandon@emspecialty.com for more info on this drill pipe. Since 1987, E&M Supply Group has been the industry leader in premium used drill pipe.

HAMMERHEAD TRENCHLESS EQUIPMENT

HammerHead's ROUGHNECK Pneumatic Rock Hammer system turns any horizontal directional drill into a highly productive rock drilling machine. The ROUGHNECK drills at rates up to 150 ft per hour — the best performance in the industry — while providing enhanced steering performance. Coupled with the universal HD high flow rock drill housing, the rock hammer expands the capabilities of a single pipe directional drill to match nearly every rock condition without changing out the housing. The patented offset rock bit design provides precise steering, allowing the operator to navigate a wide variety of ground conditions. Integrated face-cleaning exhaust ports help prevent plugging of the hammer for reliable performance, and the patented check valve located within the bit eliminates ingestion of debris. HammerHead's pneumatic hammer rock drilling system is offered in two sizes: ROUGHNECK R400 (5.125 in.) and the new ROUGHNECK R500 (6.25 in.). Both feature offset bits, patent-

pending pullback kit, control station/oiler, and drill conversion kit.

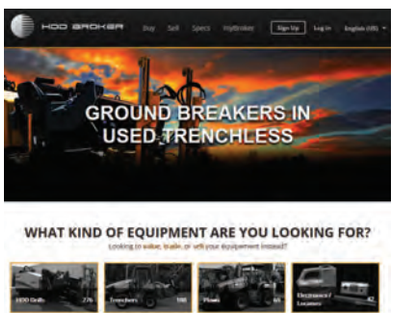
HARDROCK HDDP

The patent pending HardrockHDDP rock hammer bit is made so that a puller can be attached to the end of a drill bit.The

puller diverts air flow backward and forward to remove any debris left in the bore hole, and the back of the bit has carbide chiseled teeth to help cut its way back to the drill.This bit was made, when the hammer was in a difficult situation, to break loose from the drill string. It can also be used to insert product in a pilot bore.The patent pending HardrockHDDP rock hammer bit fits the Hardrock range of hammers (HDDP50, HDDP60), and most other hammer systems on the market.

HDD BROKER

Looking for a better way to buy or sell your equipment? HDD Broker, the industry's leading marketplace for used



utility installation equipment, has just unveiled its new website. Cleaner, faster and more powerful than ever, HDDBroker.com now features an entirely updated look with larger photos, easier navigation, and more powerful buying and selling tools. Be sure to sign up for your free myBroker account to get automatic notifications and keep track of listings you're selling or interested in buying. Everything you loved about HDD Broker is now better than ever. Check out the changes at www.hddbroker.com.

HERRENKNECHT

With 250 metric ton or 550.000 lbs of push/pull force the German engineered and built HK250C Herrenknecht HDD workhorse has now been put on track for optimum jobsite mobility. The most popular Herrenknecht maxi rig size is now available also as a crawler version with a reasonable Unit weight of only 92,000 lbs ready to drill. The onboard sound proof power pack is driven by a 640 hp CAT C18 engine ready to deliver fully adjustable 67,000 ft-lbs of torque. Thereby the power pack noise rating is at only 80dB(A) at a distance of 7 m. The main feature of the drilling system consists of the strong and full-way moveable Break-out unit, which variably clamps up to 12-in. diameter tool joints, furthermore the carriage with its unique force and torque measurement is greater than other market offers. Customers can choose between the 10 or 20ft Control Cabin with the worldwide field proven Herrenknecht control set

up consisting of Touchscreen Visualization, Operator chair with easy to operate joysticks for full control and full information. The system also includes data logging, computer diagnostics and the possibility for online remote area access for information exchange or service from anywhere in the world.

JET-LUBE

ECO-SAFE non-metallic thread compound is a premium quality compound containing carbon based fibers and additives and other natural extreme pressure and anti-wear agents. These components are blended into JET-LUBE's high temperature calcium complex base grease. The new base grease offers the additional advantage of superior adhesion to wet steel surfaces, resistance to water wash-off, and most drilling fluids. ECO-SAFE is especially effective for invert or high-pH drilling fluids. ECO-SAFE carried the ANSI/NSF 61 certification and is approved for all down-hole applications and contact with potable water. Excellent for stainless steel pump connections.

KEM-TRON

The Tango 800 mud recycling system is the perfect fit for today's drilling contractor with 140,000 to 800,000-lb size rigs in the trenchless, water-well, or geothermal industry. Capable of processing 800 to 1,000 gpm of drilling fluid, the Tango 800 unit is a high performing recycling system with a compact user-friendly design. This unit features KEMTRON's multifunctional double deck, linear motion shakers, two 12-in. desander, and ten 5-in. desilter manifolds, thus, allowing the drilling contractor to clean used drilling fluid down to 30 microns. Standard packages include three dedicated 250 series centrifu-

gal pumps, venturi hopper/mud gun injection system, Phenolic lined tank coating, hard piped manifolds, 100-ft remote operating pendant and steel discharge chutes. By combining all of this with a triple axel trailer and 150 kW generator package, the Tango 800 mud recycling system is the perfect solution for your solids control needs.

LANEY DIRECTIONAL DRILLING CO.

With 25 years of experience as a full-service HDD company, Laney's list of accomplishments is unequaled in the industry. Laney operates 17 HDD rigs

capable of completing projects with pipe sizes ranging from 3 to 60 in. and up to 15,000 ft. Laney has custom designed and produced its own drilling equipment and that means the right rig for the job every time.All of Laney's rigs are manufactured at the Houston

facility and range in size from 40,000 to approximately 1.7 million. With several P.E. engineers on staff, Laney can also provide HDD engineering services and analysis on constructability issues that may influence a pipeline crossing design. The addition of its first 750MT Direct Pipe system in 2013, Laney is even more of a full service underground installation provider. The Laney motto says it all: "There is no substitute for experience."

MCCLOSKEY INTERNATIONAL

Since 1985, McCloskey International has been bringing durable, high production equipment to customers worldwide. The newly formed Trenchless Equipment Division recently introduced the D Series drills, setting new standards in HDD with the most torque and horsepower with the smallest footprint in their class. The highly maneuverable D15 has an advanced electric hydraulic system delivering more horsepower to the ground, better fuel efficiency and guarantees 14,850 lbs of thrust/pullback while simultaneously

delivering 1,600 ft lbs of rotation. Protected in a rugged and impact-resistant case, the fully featured microcomputer supports internet and satellite communications. Interactive diagnostics automatically alert operators to service and supply needs and can order parts and regularly schedule maintenance. Combining brains and brawn, these rugged and reliable drills are ready to tackle the toughest jobs. The McCloskey Trenchless Equipment Division will supply HDD equipment to oil and gas, construction and development companies, as well as utilities including communication, power, gas and water.

METAFLO TECHNOLOGIES

MetaFLO Technologies has developed the PDM-300 for the onsite treatment of water-based liquid drilling waste. Conventional liquid waste disposal techniques add amendments like sawdust to meet solids criteria for transportation to landfill — expanding volume by 200 percent or more. The PDM-300 turns liquid waste to a solid in real time, reducing cost, improving safety, and significantly reducing the environmental impact. MetaFLO's proprietary, engineered reagent formulation, combined with its high shear mixing technology adds only a 1 to 3 percent dosage, saving you time and money through reduced transportation and landfill tipping fees. It is a robust machine, designed to operate in harsh climates and conditions. Since being introduced in 2007, the PDM has produced a successful result in locations as diverse as Northern Alberta and Australia.

M-I SWACO

M-I SWACO, a Schlumberger company, offers DRILPLEX HDD inorganic chemical viscosifier, specially engineered for water-base bentonite drilling fluids to accommodate maxi rigs and mini rigs. The HDD viscosifier improves solids suspension, enables a higher rate of penetration, optimizes cuttings transport, and creates borehole stability, thereby lowering drilling costs. DRILPLEX HDD viscosifier allows the formulation of fluids with shear-thinning properties, resulting in a drilling fluid with both dynamic and static carrying capabilities that does not degrade at a high shear rate. When enhanced mud is not circulating, it instantly reverts to a gelled state, resulting in a high suspending capacity indicated by high, non-progressive gel strength readings. Enhanced fluids develop a gel structure capable of solids suspension, but still exhibit low-viscosity flow changes. DRILPLEX HDD viscosifier fluids exhibit low viscosity at the drill bit, but still gel quickly as flow decreases, thereby carrying and suspending cuttings.

MUD TECHNOLOGY INTERNATIONAL

Mud Technology International Inc. offers a complete line of mixing, pumping and cleaning systems to meet your specific needs. The MCT-750 is trailer-mounted, built USA-tough on 15,000 tandem axles with high shear/low pressure mixing hopper, submersed jet guns in the two-section tank that combined hold approximately 3,300 gals.

Equipped with a 480v/125 kw/3 phase generator, 110-v regulated power outlet, cone manifold mounted with 10-5-in. cones, two high G-force linear shakers with more than 25 sq ft, accepts a variety of screen mesh sizes and 3 centrifugals (20, 25 and 30 hp) with a cleaning capacity up to 800-plus gpm. Unit is painted with durable industrial paint and undercoated for added protection. Equipment available for rental or purchase with the added flexibility of the possibility "try it before you buy it" option. Custom design available and superior customer service there to help when you need us.

POWERSTREAM

PowerStream has made full use of its battery engineering capability to create a new Lithium Double-C battery specifically for directional drilling sondes and locators. This battery includes laser welded hermetic cans with glass sealed electrodes, high temperature operation up to 185 F and 100 percent vibration tested. All this with the same

low price as we have always offered. Now it is affordable to use the best.

RADIUS HDD

The Radius Cobble Bit is designed for drilling in loose rock or cobble conditions but also performs very well in solid sandstone, limestone and hard compacted soils. With a combination of carbide cutters and thorough hard facing, this

bit not only offers high performance and control, but also maximum durability. Visit us online at www.radiushdd.com.

RADIODETECTION

Radiodetection's new range of precision locators builds on the high-performance and ergonomics of the RD7000+ and RD8000 platforms adding the ability to detect RF utility markers, also known as EMS or Omnimarkers. Featuring a unique automatic marker depth measurement system, which eliminates the need for a two-step manual process, and combined utility and marker locating mode, this new marker locator range delivers faster and more accurate surveys. Interfacing to maps and GIS systems is a simpler task thanks to the internal GPS options and convenient Bluetooth and USB connectivity. The automatic data logging on selected models provides operators with usage monitoring, enabling proof of work and improvement of best practice.

RAILHEAD

We've made a good thing even better. The success of the 8-, 12- and 16- EXTReam has led Railhead to the 6- and 10-in. EXTReam reamers. Now available in five sizes from 6- to 16-in. diameter. Connections are available for virtually every drill. The newly designed 6-, 8- and 10-in. EXTReam Reamers are built with an API pin and box with a removable pulling eye at the back of the reamer. This allows the user to quickly hook up many configurations.

SHAREWELL HDD

Engineered with the features operator's ask for most, like an industry-best nine 5-in. cones and a double-deck

five-screen shaker with rear cuttings disposal. In addition, there are no hand rails, walkways, or rear chute to bolt up, which means quick setup and tear down. Rugged and reliable, the Thunderstorm 2 mud cleaning system from Sharewell HDD is built for best-in-class production and value.

STRAIGHTLINE HDD INC.

StraightLine HDD Inc. introduces a 3.0 model to its RockEye line of hammers. The downsized version of the hammer system delivers the same precise streerability and rock cutting efficiency of the larger models, but will take only 300 to 400 cfm and 125 to 200 psi to operate. The tool will drill

a pilot-hole approximately 4.25 in diameter. Like its predecessors, the 3.0 RockEye hammer system comes complete with two bits, bent sub, transmitter housing, shock dampening transmitter assembly, portable break out kit and a drill pipe adapter. In addition, the 3.0 RockEye comes with a new support pack option, redesigned with space and efficiency in mind. At 28 in. long and 19 in. wide, weighing less than 150 lbs, the support pack was engineered to be manageable on the job site. Featuring an adjustable positive displacement piston pump for down-hole lubrication to the hammer; the system may be controlled wirelessly with the included battery operated remote control or from the support pack console.

TERRA-BORE

Terra-Bore High Flow End Load Housings are manufactured, totally in-house, from a single bar of heat treated nickel steel alloy. Terra-Bore housings offer the strength and versatility required by the professional contractor. Terra-Bore housings are designed to work with steering shoes, mud motors, tri-cone bits and hammers. Simple clocking mechanism is designed for use with 15- or 19-in. walk-

over or wireline sondes. Available in 3-5/8-in. diameter, 2-3/8-in. API Reg X 2-3/8-in. IF; 4.25-in. diameter Hi-Flow Housing 2-7/8-in. API Reg x 2-7/8-in. IF; 4.88-in diameter Hi-Flow Housing 3-1/2-in. API Reg x 3-1/2-in." IF; 6.38-in. diameter Hi-Flow Housing 4-1/2-in. API Reg x 4-1/2-in. IF; and 7-in. diameter Hi-Flow Housing 4-1/2-in.API Reg x 5-1/2-in. DSFH sizes, with the 8-in. coming later this year. Sidewall thickness in the 6-3/8-in. O.D. with 4-1/2-in. I.F. Box X 4-1/2-in.API Reg Box exceed 1 in., making this the strongest Hi-flow End Load housing available.

THE TORO CO.

When productivity counts, the new Toro DD4045 horizontal directional drill delivers. Combining 40,000 lbs of best-in-class thrust and pullback, along with 4,500 ft-lbs of torque and drilling fluid pump infinitely variable up to 70 gpm, the DD4045 provides

the flexibility to perform a variety of different bores. Operators will appreciate the flexibility to use either single or dual joystick controls while drilling, the large multi-function LCD display, and the clear visibility of the tool joint that comes from having open-top vice wrenches. Optional enclosed operator cabin. Contact an authorized Toro Underground Dealer to arrange a demo and see it for yourself.

TORQUATO

TORQUATO is pleased to announce the introduction of its all new HDD PDC Reamers. The reamers are manufactured in a strong, one-piece design with "no moving parts." Its reamers are custom manufactured up to 30 in. in diameter to meet customer requirements. The smooth cutting action of the premium PDC cutters results in faster reaming and less wear and tear on the drill string and drill rig. The line of HDD PDC Reamers is the latest product in Torquatos's HDD line of tooling, which includes its SILVER BULLET HDD PDC Pilot Bits.

UNITED CITY GROUP

United City Group has successfully repaired thousands of broken Digitrak, Spot D Tek and Subsite transmitters considered non-repairable in the past. Repair services backed up by our world-class 100-day warranty and swap out options make its repair services a must have for all horizontal directional drilling contractors.

UNDERGROUND TOOLS INC.

Underground Tools Inc. is excited to announce the introduction of its new lineup of Heavy-Duty Maxi Rig Sonde Housings. Manufactured from a single bar of heat-treated Nickel Steel Alloy, which offers superior impact and abrasion resistance, these housings offer more strength and versatility than anything on the market today. They are designed to work with slant-face steering heads, roller cone bits, mud motors and even hammers. These high flow housings have epoxy filled slots and are more than capable of delivering the fluids required by maxi rigs, as well as dissipating heat and keeping the electronics cool. Housings are available in end-load or side-load transmitter access configurations, along with being wire line capable. With sizes ranging from 4¼- to 7-in. diameters UTI has a heavy-duty housing for every application.

VACUWORX

Vacuworx, a leading manufacturer of innovative vacuum lifting technology and heavy-duty material handling equipment, has launched a lightweight pipe handling system to lift and position drill stem in horizontal and directional drilling operations. The HDD Pipe Handling System uses wireless remote controller operation and the latest vacuum-lifting technology to tilt and place drill stem at angles between 0 and 30 degrees without the use of ropes or slings. Suitable for use with Vacuworx MC Series Lifters, the HDD unit is significantly lighter weight than competing technologies and requires only one worker to lift drill stem and transfer the pipe into a drilling rig, reducing exposure to risk of injury in a pipe yard or on a jobsite. The unit is compact yet highly durable and well matched to meet the rigorous demands uncovered by contractors or municipalities looking for ways to decrease load times and bolster safety during the course of trenchless HDD applications. The equipment features a 360-degree hydraulic rotator that gives operators complete control over drill stem and allows for the precise placement of pipe joints with fewer workers on the ground.

VERMEER

Vermeer has introduced its first horizontal directional drill with a Tier 4 Final engine. The D9x13 S3 Navigator HDD features improved hydraulic efficiency and enhanced speed for greater drilling performance. The D9x13 S3 is designed for installation of utilities such as communication, power, gas and water, as well as some limited sewer applications. With the smallest footprint in its class, this machine is ideal for installation projects in congested urban areas. The D9x13 S3 has a 44-hp, Kubota Tier 4 Final engine, delivering 9,000 lbs of thrust/pullback and 1,300 ft-lbs of rotational torque. A new hydrostatic hydraulic system for the thrust and rotation circuits increases the system efficiency, allowing better use of engine horsepower and increasing the D9x13 S3 productivity. This new hydraulic system also improves the ground drive speed by 60 percent over its predecessor.

WYO-BEN INC.

Since Wyo-Ben Inc. introduced TRU-BORE in 1992 it has been the industry leader in HDD fluids. It is a highly concentrated bentonite based drilling fluid that is extremely effective in difficult drilling situations from clay soils to sands and gravels. TRU-BORE is fast mixing, builds viscosity quickly, has low fluid loss, and exhibits excellent gel strengths. These factors, along with being NSF certified, make TRU-BORE® the best risk management tool available.

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Trenchless Technology Supplement

AD INDEX

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- Innovations
- Networking Events

NASTT's No-Dig Show offers a first-rate educational program that rivals no other! Ask George Ragula, No-Dig is his go-to show for a comprehensive technical program, knowledgeable people always willing to share trenchless experiences and exposure to cutting edge technologies that all help provide him with technical solutions to reduce his company's construction costs. Attend the educational sessions at NASTT's 2015 No-Dig Show and find cost-saving solutions for your company!

Pictured above: George Ragula, Distribution Technology Manager, Public Service Electric & Gas (PSE&G), Newark, NJ

Mark your calendar and make your plans to attend NASTT's 2015 No-Dig Show in Denver, Colorado.

nodigshow.com